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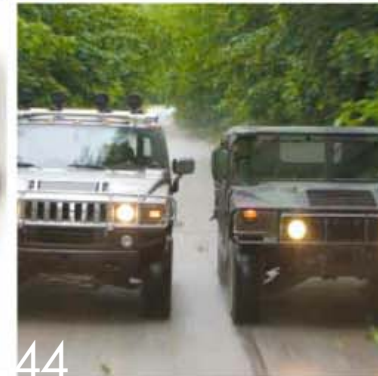
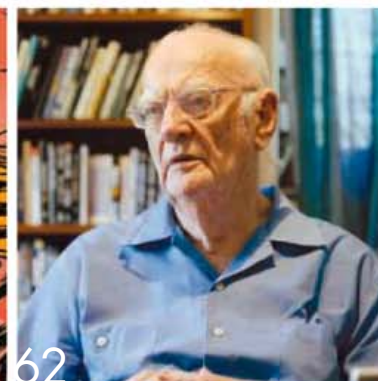
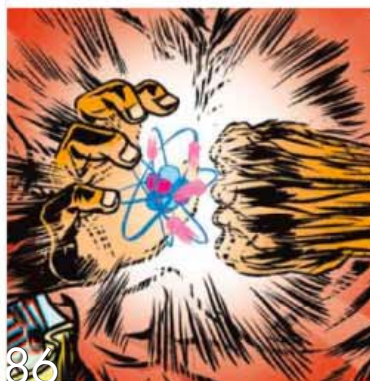
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"Your PDA tells you many things. It entertains with games and MP3s. But it does not tell you to step right to avoid a landmine."

MILITARY TECH VERSUS STREET TECH p. 47



I'm Outta Here— the Debate Goes On



THIS IS THE LAST MONTH THAT I'LL BE WRITING THIS COLUMN as Editor-in-Chief of POPULAR SCIENCE. I'm not leaving the magazine, but I am handing the day-to-day running of it over to the new editor, Mark Jannot, while I work on long-term plans and new ideas. My tenure here has been a very fun one, just short of three years long—during which POPSCI has changed rather more than it had in the previous 30.

I mention the transition for a couple reasons. First, because the response to this monthly editorial has provided gratifying proof that POPSCI readers are acutely interested in cultural and policy issues relating to science and technology (even as they enjoy reading about whizbang gadgets and the dreamers who still want to build a flying car). The prevailing view in the magazine world is that no one reads editorials except the editor's mother, but if that is the case, then my mother has been very busy firing off letters from all over the country and globe. (Thanks, Mom.) Most notably, I received a tsunami of mail commenting on the January 2004 editorial mourning the state of scientific ignorance in this country.

Not everyone has liked the perceived politicization of this space. I stand accused of being a Communist (!), a godless dupe of the evolutionists, a gun hater, a war worshipper and a stooge for the climate-change jihadists. All true. But for the most part, readers have been interested in the meat of the arguments, pro and con, and share my view that science is not just about enquiry but about how the products of this enquiry (i.e., technology) are used, or abused.

The second reason I mention this transition is because I need to thank the readers of this magazine for being so loyal and responsive during a time of change. POPSCI has been changing because I happen to believe that this country needs, in a real hurry, a popular science and technology magazine that is every bit as well-known as the most prominent magazines in the nation. The dialogue about science should match, in weight if not in volume, that about politics, education and *American Idol*; and it certainly needs to keep pace with the torrid progress of technology in our world. This magazine should feature large in the public—that is, the *popular*—debate. The job of realizing that ambition is obviously not done, but it is nicely under way, and the new editor is eager to charge ahead.

A fast-paced magazine for a fast-paced world, in other words: There are more changes to come in these pages, certainly, but each change will be an honest attempt to reflect the vital role that the pursuit of scientific knowledge plays in the crazy human drama. And to show you some cool gadgets and flying cars.

Want to take any final shots? Send them to the e-mail address below. Or welcome the new editor at mark.jannot@time4.com. His e-mailbox will always be open.

SCOTT MOWBRAY

scott.mowbray@time4.com

POPULAR science

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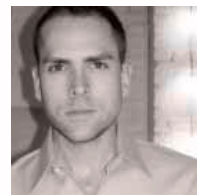


CONTRIBUTORS



PopSci associate editor **GREGORY MONE** (left) and photographer **JONATHAN WORTH** (right, with daughter, Sidney) infiltrated the world of the Singularity for this issue's investigation into the rather uncertain future of science fiction (page 54). The Singularity is a moment, expected to arrive within the next 20 years, when rapid-fire technological leaps will push humanity into an unforeseeable future. Mone spent a few mind-wrenching days with Singularity soothsayers Cory Doctorow and Charles Stross, both up-and-coming science-fiction writers living across the pond. Worth, a documentary photographer who shuns unnatural lighting, made portraits of Doctorow and Stross in their native habitats. Both he and Mone came away with the same impression: These Singularity guys are *brainy*. "It's awe-inspiring," Mone says. "They know more than you on every subject." The experience incited a mini conversion in Mone, PopSci's resident techno-skeptic (he writes the "Luddite" column in the How 2.0 section). "During our conversations, I wanted a wearable computer so I could Google things to keep up," he admits. Pausing to reflect on the unnerving possibility of being strapped to a computer 24/7, he observes, "Maybe this is the future."

When shooting Olympics-bound swimsuits for the What's New section (page 20), photographer **GREG BROOM** encountered an unexpected snag: the 6-foot-4-inch model he'd hired was too big for the suits. "The zippers kept breaking," he recalls. It was embarrassing for all involved, but the model made do. "I don't know [how]," Broom says, "but I believe that baby powder was involved."



LAURA ALLEN had an in when investigating Metal Rubber, a material that's flexible yet conducts electricity (page 36)—her dad is a chemist. Allen is no stranger to science herself. As an editor at *SuperScience*, she built catapults for marshmallow flinging and sailed paper airplanes across the office. "Anything to get away from what kids have already seen, like 'the volcano,'" she says. "I am very anti-volcano."

JAMES VLAHOS wasn't in the habit of chatting with military types before reporting our head-to-head comparison of consumer and combat gear (page 44). But, Vlahos confesses, he now suffers from some serious gadget envy. "I really want a helmet-mounted cueing system," he says. "You know—you look at the coffeemaker to turn it on and simultaneously track the newspaper by radar as it's flung onto the front porch."



PopSci contributing artist **GARRY MARSHALL** ("Mercury or Bust," page 34) honed his science-illustration chops after a stint doing 3-D animations—"the usual flying-logo stuff," he says, "but also animated diagrams of how machines work." Marshall's latest project, *Rogue Farm*, an animated film for Scottish television, is based on a story by Charles Stross, who just happens to be the subject of an article on page 54.

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Looking Back with Love



Many thanks to POPULAR SCIENCE and Larry Smith for the look back to 1954 ["Tech '54, Where Are You?" June]. I've got 30 years on the author and remember 1954 with affection as my sophomore year at a small-town high school in northern Illinois. I was one of only three boys in the typing class, which served me well in more than 35 years in journalism. Coach Wilkinson taught driver's ed using a 1954 Ford sedan with three-speed manual shift on the steering column—no power steering for a lowly Ford! I took my driving test in that car in January 1955, and my license was a Photostat with no picture on it. Those cars were distinctive; I wish I had all the pre-World War II Chryslers, Buicks and Fords I owned in high school and college today. Photography, one of my hobbies then and now, was strictly black-and-white, and darkroom work was in its prime.

A wonderful story, beautifully written.

*David M. Kinchen
Hinton, W.V.*

I enjoyed the article on 1950s tech, but the premise was flawed. As an 11-year-old kid in 1954, I can report that things weren't bad at all.

You say that the windup alarm clock was too loud? You could have used a clock radio. My parents had an Emerson model. Like all electronic appliances, the radio used vacuum (not cathode-ray) tubes.

In those days a telephone call connected you to a person. Small businesses had a receptionist; larger companies had one or more telephone operators to answer and direct your call. If the Western Electric phone broke, a call to the

repair service sent the repairman to your home within a short time.

The author certainly could have had a cheeseburger and fries. There were drive-in restaurants well before the 1950s. It just wasn't called fast food then.

And of course the technology of the time was appropriate. Watching modern TV shows on a 50-year-old set isn't the same as watching Kukla, Fran and Ollie or Jack Benny—it was live theater then. While we were in front of the tube watching, they were in the studio performing.

Thank you for an informative

article, and welcome back to 2004! You did remember to wind your wrist-watch every day, didn't you?

*Austin Matlow
Jeffersonville, Ind.*

Spare Us the Rods

Space weapons may have strong emotional appeal, but from a technical point of view it is amazing that some of these ideas persist. "Rods from God" ["Is This What War Will Come To?" June] is a good example. For quick delivery to a target on Earth, the rods must be in relatively low orbit and would therefore move with respect to Earth. So having a satellite in place to deliver a rod to a given point on Earth within 30 minutes would require having 20 to 30 satellites in orbit. Once a rod is in orbit, it can't just be "dropped"—the satellite must carry fuel to accelerate the rod out of orbit and back down to Earth. That fuel must be launched into orbit along with the rod. Moreover, putting a mass into orbit takes roughly twice as much energy as shooting that same mass by long-range ballistic missile.

Due to all these factors, using an orbiting rod to attack a target within 30 minutes of a decision to do so

(LETTERS, CONTINUED) ►

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FROM "AVIATION CULT" TO "ZIMMER LABORATORY"

Your guide to this month's PopSci.

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LETTERS

requires more than 50 times as much space launch capability as is required to deliver a similar rod to a target in 30 minutes using a long-range ballistic missile.

David Wright

*Union of Concerned Scientists
Cambridge, Mass.*

I read your article about spears from space with interest. The concept of "rods from God" is probably scientifically valid, but I am disappointed that you make no mention of the treaties the U.S. has signed banning weapons from outer space. We have already stretched that a bit with military reconnaissance, navigation and communications satellites, but this would take things to a much higher level.

War in space reminds me of a program I watched on how if we had a collision of satellites in orbit, the debris would scatter and hit other satellites, and those would hit others, until we had an entire orbital band full of lethal flying debris. That could eliminate the possibility of manned deep-space exploration for centuries. Putting weapons in space increases the odds that someone will try to destroy that weapon system and start that deadly cascade of collisions.

Besides, if you hang a sword over your neighbor's head and leave it there for years, he isn't likely to loan you his lawn mower unless you take it by force. Not the best basis for peace in the neighborhood.

Don Daniels

Evergreen, Colo.

Popular Propaganda?

POPULAR SCIENCE should really ask itself whether the lighthearted review of *The Day After Tomorrow* ["Hollywood, Science and the End of the World," June] was a responsible way to treat one of the worst excesses of Hollywood scare-mongering-for-profit that we have seen to date. I could easily have chosen three scientists with less taste for this sort of exhibitionism than writer Matthew Teague's three Oracles. So the makers admit to exaggerations. The fact remains that director Roland Emmerich uses the medium of film in the same

way his predecessor Leni Riefenstahl did. Older readers may remember her as Hitler's favorite maker of propaganda films (*Triumph of the Will*) that brought millions to Nazism. Your magazine has a large readership of all ages. I shudder when I see what we are feeding our younger generations in unadulterated junk science. POPULAR SCIENCE should be in the forefront of those who decry it.

Albert Jacobs

Calgary, Alberta

Which Gave Birth to an Era?

In your article about the proposed Boeing 7E7 Dreamliner ["Boeing, Boeing, Gone?" June], you made the comment that Boeing gave birth to the jet age when it introduced the 707 jetliner. Aren't you forgetting the British-built DeHavilland Comet? Admittedly, the Comet had a bit of a checkered history due to the unforeseen effects of metal fatigue, but it was operating well before the advent of the 707.

Petar Novakovich

Caerphilly, South Wales

Author Bill Sweetman replies: Yes, the Comet 1 was in commercial service before the 707; however, it was the 707 (and DC-8) that provided the performance, economics and safety needed to replace piston-engined DC-7s and Constellations. Although the DeHavilland certainly deserves some credit, it can't expect it all the time.

FROM THE BLOGS

Last month, over 250 Web logs linked to popsci.com. A sample:

Tech '54, Where Are You?

In the spirit of "You've come a long way, baby," POPULAR SCIENCE has an intriguing article involving a writer having to live with technology available to the average person in 1954. It's nothing like having to live at an Iron Age technological level, but it makes you realize how much tech we need to get by in today's society and how much we've come to expect. Cable television, PDAs, any number of foodstuffs . . . not to mention Theraflu.

posted by Paul Riddell

*The Esoteric Science Resource Center
livejournal.com/users/sclerotic_rings*



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What's New

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▶ Tag Heuer has always ruled the racetrack—from its Carrera chronograph in the 1960s to last year's SLR, designed to resemble the Mercedes-Benz supercar of the same name. But never before has the Swiss watchmaker gone so far as with the Monaco V4, which reaches under the hood to take inspiration—both aesthetic and technological—from the internal combustion engine. Unveiled as a prototype this past April in Basel and not yet scheduled for release, the V4 is the first wristwatch ever to run on drive belts.

Automatic watches ordinarily use dozens of gears to power movement, but belts are more efficient because they cut out the friction inherent in a chain of cogs.

The V4, which took 20 months to develop, uses 13 half-millimeter-wide synthetic belts. They drive metal wheels that rotate on low-friction microball races rather than the synthetic

FRONT



TAG, YOU'RE IT: The first watch to use drive belts to power movement.

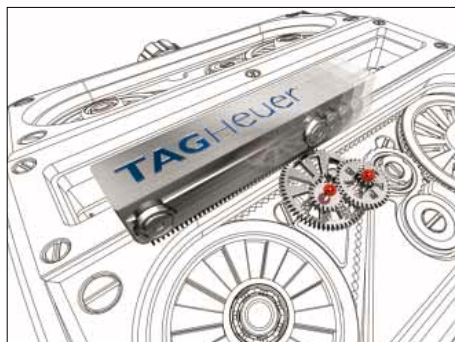
BACK



WATCH THE REVOLUTION: Three panels of synthetic sapphire provide a peek under the hood of this chronometer.

ruby pivots known as jewels. The movement is powered by a platinum ingot that shuttles back and forth to turn a cog as you move your wrist. The drive belts transfer that torque to four spring-loaded barrels, which run a balance wheel (more belts) that ticks off the hours, minutes and seconds indicated by the watch's hands.

While none of these changes are exactly necessary, the V4 falls into a long and illustrious line of watchmaking innovation, otherwise known as showing off. Critics point out that a weight limited to moving along one axis can capture only a fraction of the energy that one free to pivot 360 degrees can. What they're ignoring is the watch's aesthetic—and the audacity of its design. The V4 won't set watchmaking on its head in the way ultra-accurate, low-cost quartz movements did in the early 1970s, but it may be the biggest innovation since then. Either way, it'll cost you between \$6,000 and \$12,000. —JONATHAN KEATS

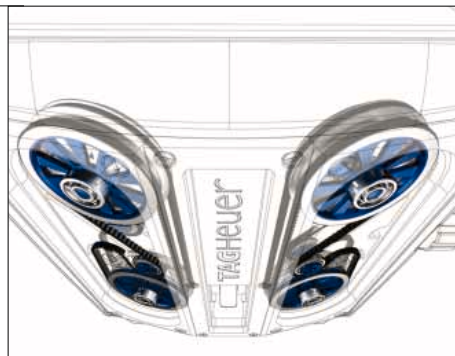


THE ENGINE

A 4.25-gram platinum ingot slides back and forth in a central channel at the back of the watch, capturing power from the wearer's wrist movements. The ingot is machined with teeth along one edge that engage a cog at the side of the channel, rotating it with each pass.

THE TRANSMISSION

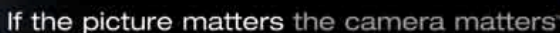
Four synchronized barrels, each containing a metal spring, store enough energy to run the V4 for 50 hours even when you're not wearing it. The barrels turn the movement using 13 0.5mm-wide belts tightened with minuscule turnbuckles to a tension far beyond what jeweled pinions could sustain.



COURTESY TAG HEUER

[illegible]

The new Nikon **D70 Digital SLR** shoots 3 fps for a continuous burst of 144 shots—so you can't miss.



Nikon
At the heart of the image



LOSE WEIGHT NOW

THREE SUPER MODELS THAT INSPIRE PRECISELY FOR WHAT THEY LACK.



For engineers, trimming away ounces and pounds isn't an impressive end in itself.

Light weight, in order to carry heavy significance, must inform some aspect of a product's utility. But finding the line between functionally gossamer and just plain flimsy can be confounding. These featherweights strike a perfect balance. —STEPHEN F. MILLIOTI

SUPERLIGHT CHAIR 6.5 lbs.

It's easy to make a 6.5-pound aluminum chair; it's less easy when Mr. Frank Gehry himself wants it to flex a bit. The challenge with the Superlight, designed by the famous architect and manufactured by Emeco, was to manipulate what is not typically a flexible material. The frame consists of aluminum tubes that are cold-formed to save the weight of welding and then heat-treated for strength. They bend under load because of a proprietary alloy, the thinness of their walls (1.6mm) and the way they bow away from the chair back. The slinglike seat is a sheet of 1.6mm-thick brushed aluminum, hemmed at the edges to give it structural integrity. \$350; designwithinreach.com



SONY VAIO X505 1.75 lbs.

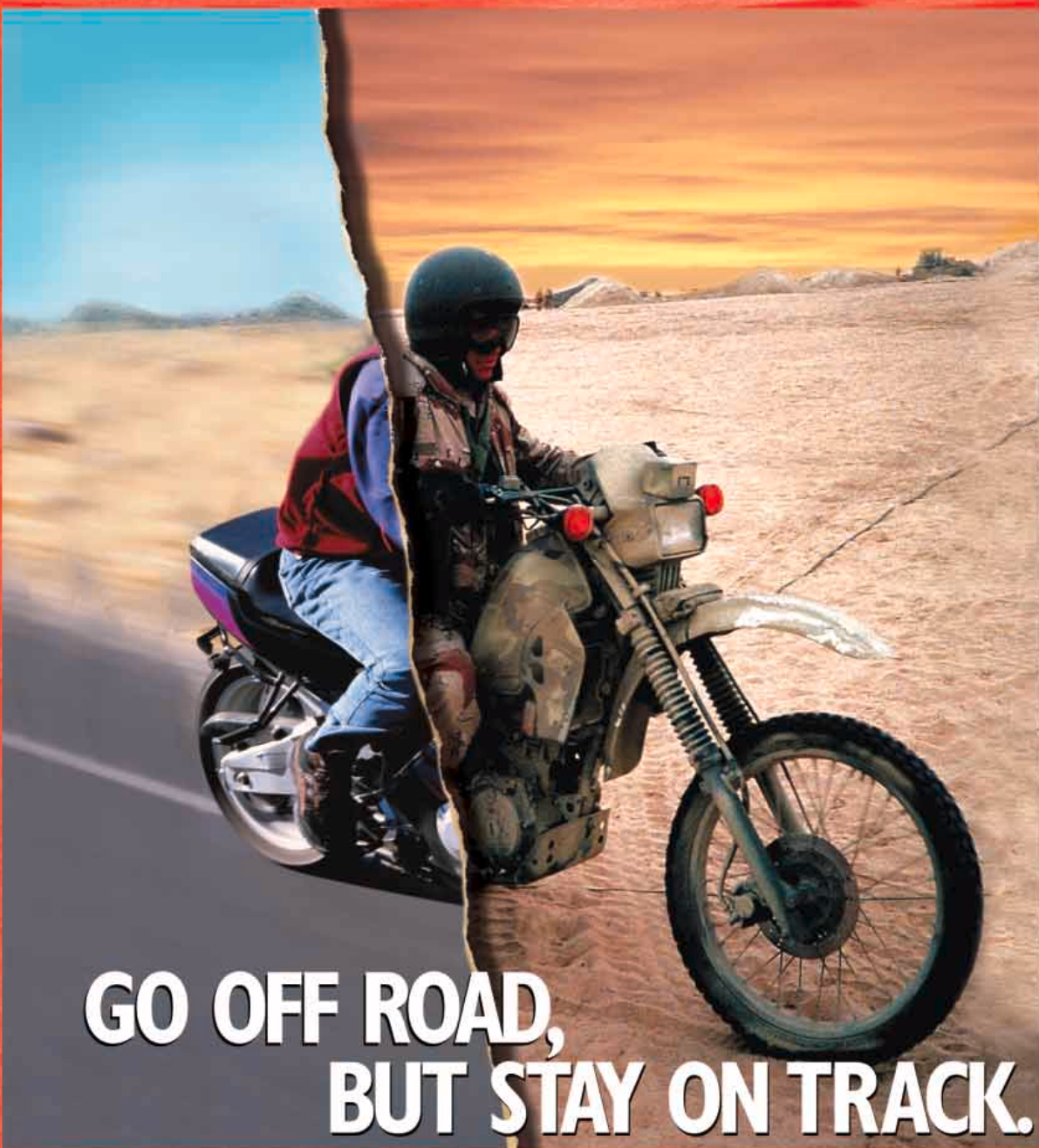
The new X505 is the lightest laptop in the country, thanks to a carbon-nickel casing that's both lighter and stronger than carbon fiber. The absence of a fan also pares weight: The Intel Pentium M processor is a low-power-consumption chip to start with, and the conductive nature of the carbon nickel combined with two exhaust ports easily dissipates the little heat it produces. Yet it has a grown-up 10.4-inch screen and a 20GB hard drive. It's a notebook smaller than an actual notebook. \$3,000; sony.com



LOTUS ELISE 1,975 lbs.

The skinny here is that the car's chassis, made of bonded, extruded aluminum, weighs just 150 pounds. And the molded composite body is significantly lighter than standard fiberglass. Introduced in the U.S. in June as a 2005 model, this mid-engine roadster has a 1.8-liter, four-cylinder Toyota Celica engine that produces 190 horsepower. That may sound anemic, but the engine needs to push only 1,975 pounds. The result? Zero-to-60 in 4.8 seconds, and it moves like a cheetah. Even the pedals are extruded aluminum. Says Steve Swift, the company's engineering chief: "It's the most Lotus Lotus we've ever made." \$40,000; lotuscars.com





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GAMES THEORY

INSIDE THE GEAR THAT'LL GIVE ATHENS-BOUND ATHLETES THEIR EDGE— AND GIVE YOU A LEG UP ON COSTAS.

It all started with track and field, so we will too. These events are athletics distilled to a jump higher, run faster simplicity lacking in modern sports. Yet behind the ideal are the thousands of hours (and millions of dollars) sponsors spend on engineering products to give their athletes an advantage. The best part? You can use the same stuff the Olympians do. —BEN HEWITT

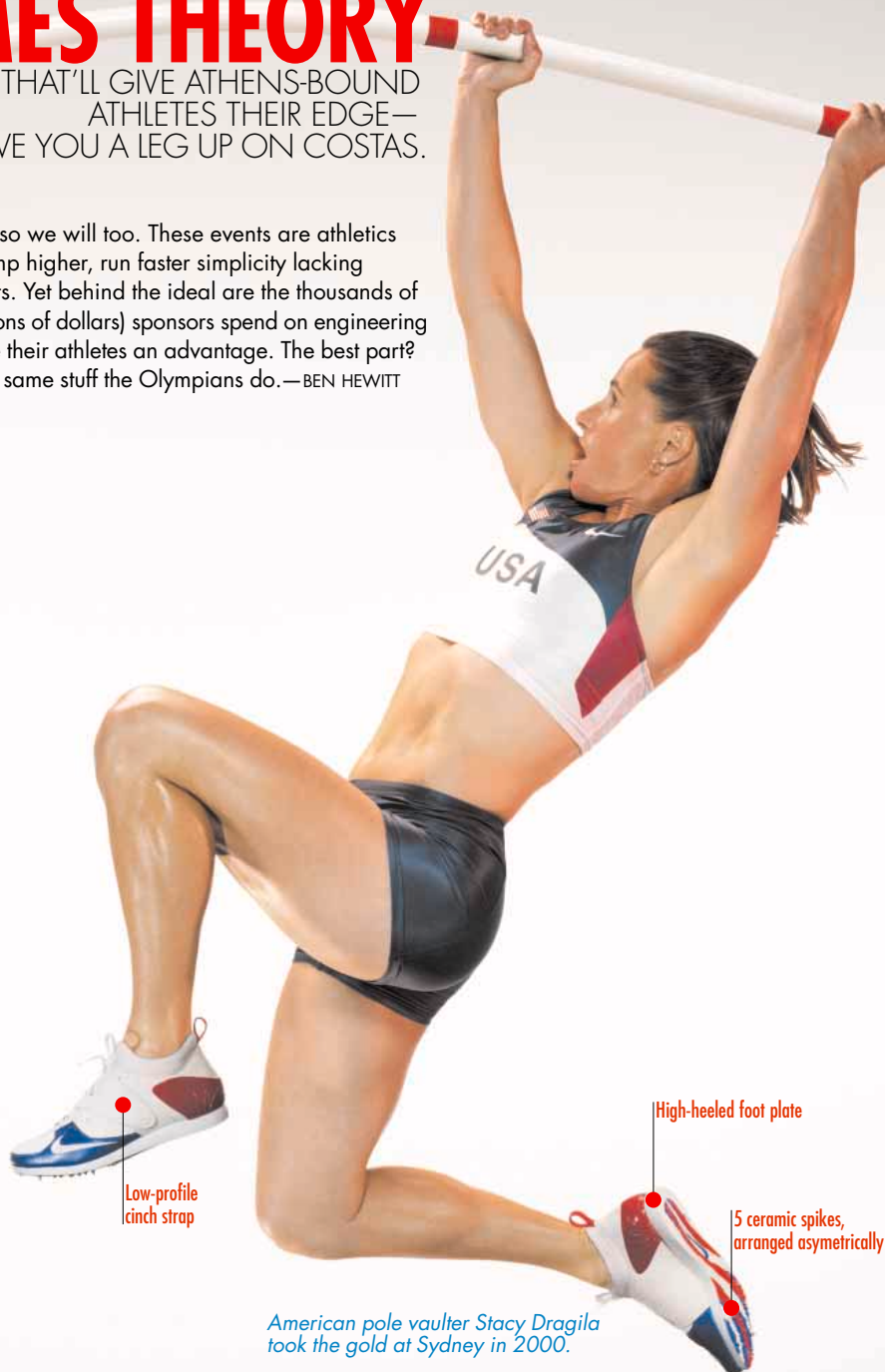
POLE VAULTING

NIKE PV LIGHT

Pole vaulters have always relied on footwear borrowed from long jumpers and triple jumpers. Problem is, vaulters don't run like jumpers: Sprinting while carrying a 17-foot fiberglass staff requires an upright posture. Nike designers and former collegiate pole vaulters Tinker Hatfield and his brother Toby built a shoe with a glass fiber-infused plastic foot plate that tapers from 15mm at the heel to 7mm in the forefoot to reduce Achilles tendon strain during the sprint and to increase stability on takeoff. The upper is made from AeroPLY, a breathable, stretchy thermoplastic fabricated from melted resin pellets spun into strands. The material helps keep weight to less than 14 ounces a pair. Price not set; nike.com



Low-profile cinch strap



High-heeled foot plate

5 ceramic spikes, arranged asymmetrically

American pole vaulter Stacy Dragila took the gold at Sydney in 2000.

DISTANCE RUNNING



ADISTAR COMPETITION

The Mediterranean sun is expected to sear Athens road surfaces, so Adidas lined the insole and side stripes of this shoe with metallic 3M foil to reflect heat. The pair weighs a mere 14 ounces. \$100; adidas.com

SPRINTING



JW FOSTER SPRINT

Because less is more in sprint shoes, Reebok made a cast-polyurethane upper for its 11.2-ounce (a pair) sprinter. By molding the overlay to the midsole, designers eliminated the weight of seams and stitching. \$85; reebok.com



Thousands of Possibilities

GET YOURS



HEY, NICE SUIT!

AND YOU THOUGHT SWIMMING WAS A LOW-TECH SPORT.

Swimsuit makers agree that even elite swimmers squander 92 percent of their energy to three types of resistance: friction drag, caused by water grabbing at skin or suit; pressure drag, resistance created by the body's shape and mass as it pushes through a fluid 830 times as dense as air; and wave drag, the by-product of the swimmer's wake. Which type of resistance is most crucial to overcome? And how best to limit the effects of each? That's where the consensus ends. —B.H.

Japanese swimmer Kosuke Kitajima, world champion in the 100-meter breaststroke (long course)

NEUTRALIZERS

If a swimmer were a car, his inner forearms would be the tires, converting energy into forward motion. That's why Speedo equipped this area with titanium-silicon scales that grip water on the downstroke.

SWIMMING

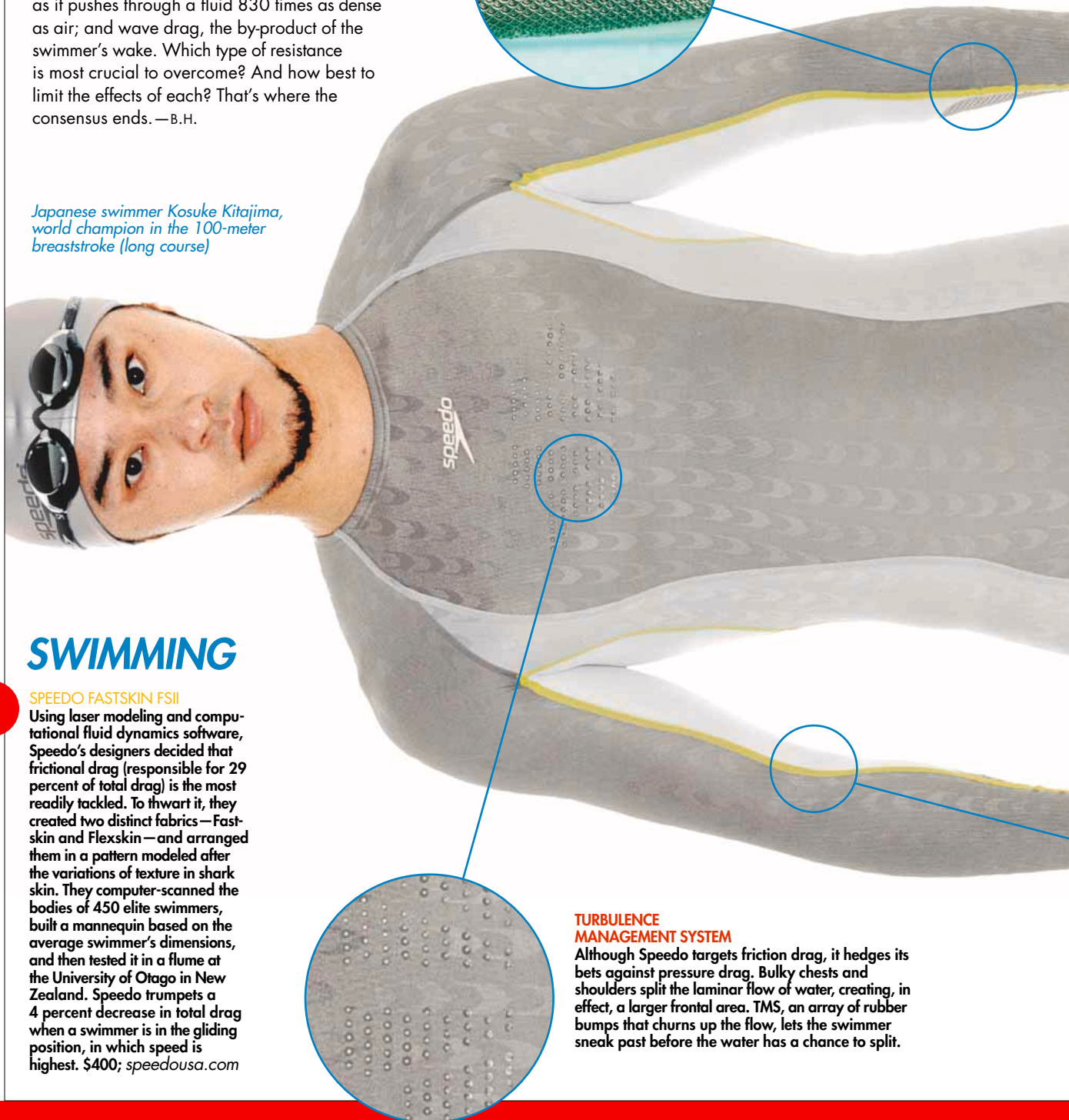
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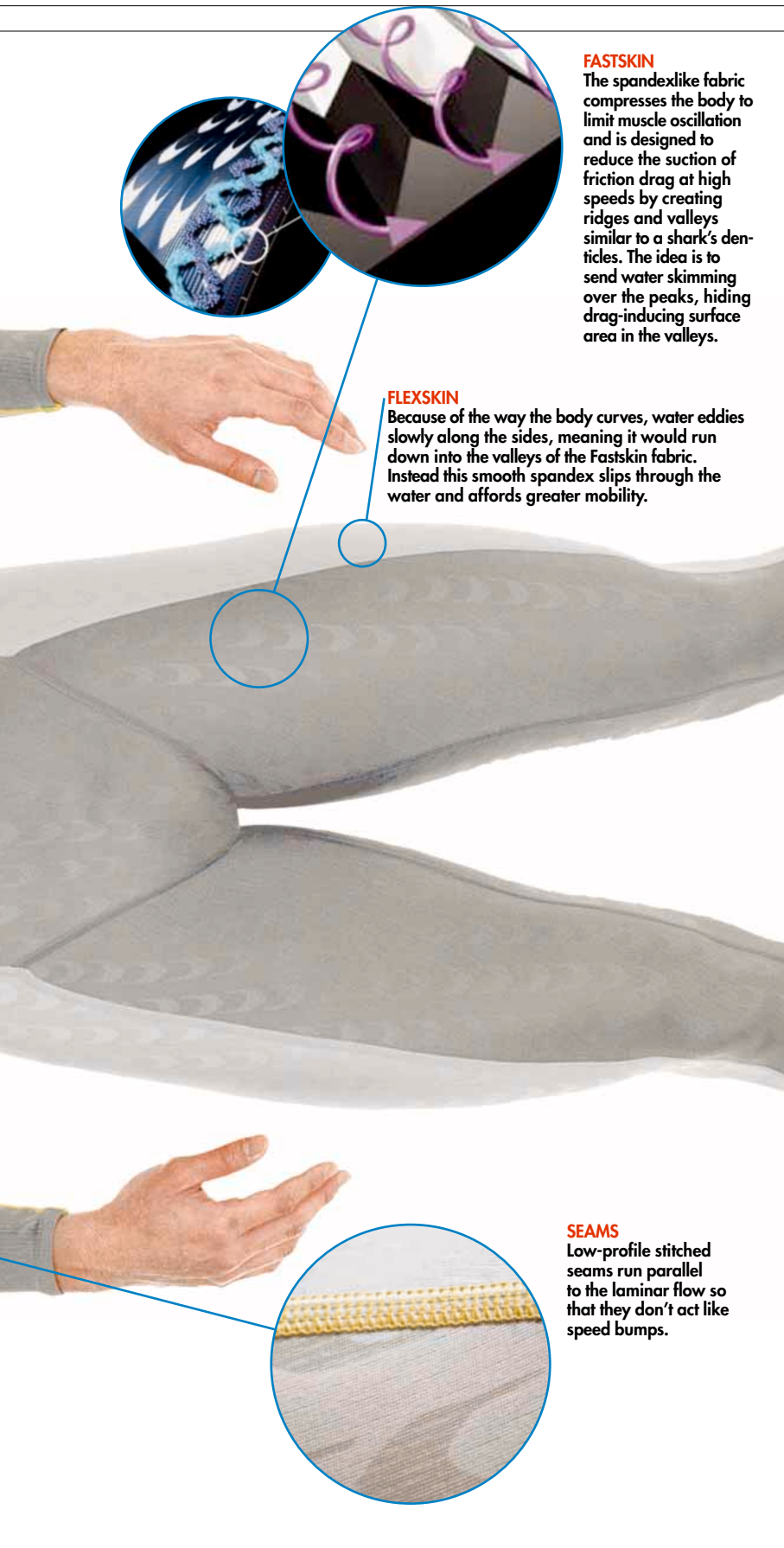
SPEEDO FASTSKIN FSII

Using laser modeling and computational fluid dynamics software, Speedo's designers decided that frictional drag (responsible for 29 percent of total drag) is the most readily tackled. To thwart it, they created two distinct fabrics—Fastskin and Flexskin—and arranged them in a pattern modeled after the variations of texture in shark skin. They computer-scanned the bodies of 450 elite swimmers, built a mannequin based on the average swimmer's dimensions, and then tested it in a flume at the University of Otago in New Zealand. Speedo trumpets a 4 percent decrease in total drag when a swimmer is in the gliding position, in which speed is highest. \$400; speedousa.com

TURBULENCE MANAGEMENT SYSTEM

Although Speedo targets friction drag, it hedges its bets against pressure drag. Bulky chests and shoulders split the laminar flow of water, creating, in effect, a larger frontal area. TMS, an array of rubber bumps that churns up the flow, lets the swimmer sneak past before the water has a chance to split.





FASTSKIN

The spandexlike fabric compresses the body to limit muscle oscillation and is designed to reduce the suction of friction drag at high speeds by creating ridges and valleys similar to a shark's denticles. The idea is to send water skimming over the peaks, hiding drag-inducing surface area in the valleys.

FLEXSKIN

Because of the way the body curves, water eddies slowly along the sides, meaning it would run down into the valleys of the Fastskin fabric. Instead this smooth spandex slips through the water and affords greater mobility.

SEAMS

Low-profile stitched seams run parallel to the laminar flow so that they don't act like speed bumps.

TYR AQUA SHIFT

How can more frictional drag help you swim faster? According to TYR, when it's allowed for the greater good of reducing wave and pressure drag. The suit has 3mm spandex and polyester "tripwires"—latitudinal ribs across the chest and rear—designed to create turbulence that pushes you along. \$260; tyr.com

2

Tripwires: More pronounced than Speedo's TMS, these break the laminar flow so it doesn't split into two streams.

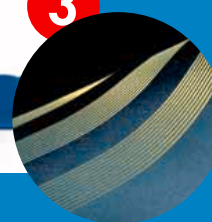


ADIDAS JETCONCEPT

Adidas takes a different tack, focusing on the 154 pounds of dead water weight that rides in the hollow of the lower back. A wedge of terraces along the back shunts water to the sides, allowing the athlete to ride higher in the water, thus decreasing all forms of drag. Adidas claims as much as a 3 percent boost in performance. \$350; adidas.com

3

Terraces: Patterned protrusions on the rear redirect water.



Hydrogasket: Swimmers squeeze in through a silicone cuff, so no need for a drag-inducing back zipper.

4

NIKE SWIFT SWIM

Arguing that the turbulence created by eight swimmers churning up the pool makes friction drag unmanageable, Nike went after baggy fabric. They use glued seams, which stretch twice as much as sewn ones do, for a skintight fit to keep out water. The fit also reduces tissue deformation, an agent of friction drag. Price not set; nike.com



GOLD IS IN THE DETAILS

MICROMANAGING MILLIMETERS AND MATERIALS IN THE NAME OF TWO-WHEELED SPEED.

Bike racers are the biggest geeks at the Summer Games. They have to be, because they rely so much on machines that can fritter away power through structural wobbles and aerodynamic drag. Which means cyclists tend to handpick every part they use, analyzing each choice to within a millimeter of its efficiency. —B.H.

SPECIALIZED TARMAC

By fusing a wishbone-shaped carbon-fiber upper to an aluminum lower frame, Specialized cooked up a bicycle that's at once laterally stiff and vertically compliant (for comfort during the six-hour road race). It's also light: The Tarmac frame is just 2.8 pounds. \$2,710; specialized.com

EASTON ATTACK HANDLEBAR

Monocoque carbon-fiber wings impart stiffness for precise steering yet dampen numbing vibrations, nice for the 30-mile time trial. Cantilevered elbow pads help with the damping and offer a wide range of adjustments—important for fussy cyclists. \$700; eastonbike.com

CYCLING

LOOK KEO PEDALS

Pro cyclists demand opposing qualities from pedals. They want good size for stability and low weight for climbing. The carbon-injected body in this model keeps weight to 115 grams each, the lightest large-platform pedals in the world. \$220; veltecsports.com

GIRO REV SIX

A rule change in January sent helmet makers scurrying to create time-trial lids that aren't merely fairings. After 25 hours in a wind tunnel—and a lot of nitpicking from Lance Armstrong—Giro delivered a foam-lined shell that's aerodynamic and protective. Price not set; giro.com

TUBELESS ROAD TIRES

Mavic and Michelin are developing tires that finally dispense with the inner tube. To create an airtight chamber, the valve screws into the wheel, and the tire bead seals against the rim. The big deal for racers is improved road feel. The key for you and me is lower risk of flats. Price not set; mavic.com

FULL SPEED AHEAD K-FORCE CRANKSET

A molded carbon-plate spine down the center of the arms gives them structural integrity. Sandwiched between the spine and the woven carbon shell is lightweight foam. Weighs 660 grams with chain rings. \$500; fullspeedahead.com

MOUNTAIN BIKING

ROCK SHOX ATHENA

At 2.71 pounds, the Athena is the lightest suspension fork on the market. The trick? A one-piece carbon-fiber crown and steerer tube, as well as magnesium pistons inside. A handlebar-mounted lever allows you to adjust the rate of compression to suit the terrain. Three inches of travel. \$850; rockshox.com



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Media Multipack

iRiver Prism Eye >> A lithium-ion battery gives you 35 hours to play MP3s, record voice memos, take 0.3MP snaps, or listen to FM radio. The device is the size of a roll of quarters. 256MB flash memory. \$280; iriver.com



Hinge Benefits

Motorola MPX >> A dual-axis hinge on this GSM smart phone lets it open like a flip phone or a wee laptop. Qwerty keyboard. 1.2MP camera. Wi-Fi and Bluetooth. Price not set; motorola.com



Easy Squeeze

Staple Gun Power Stapler >> A spring-loaded lever reduces by 80 percent the force you need to apply. (Take out your aggression elsewhere.) \$15; staples.com



OCD Dream Come True

Intelli Innovations Cordless Collector >> Inventory your media with a Bluetooth barcode scanner that links to your OSX.3 Mac and pulls names of CDs, books and DVDs from the Web. \$300; intellisw.com



Go Ahead, Make My Game

Monstergecko Pistolmouse FPS >> Pivot your shooter simply by rotating the controller—an 800-dpi optical sensor, offset from the butt of the gun, tracks hand movements. \$70; monstergecko.com



X Prize Contender?

Estes Hydrogen Fuel Rocket >> A projectile that makes its own fuel: The battery-powered base station uses electrolysis to get the H out of H₂O and then ignites it—sending your toy sky-high. Goes 200 feet. \$50; estesrockets.com

Take It Away

HP Media Center PC m1090n >> Forget external hard drives. No need for them if your machine has an auxiliary hard drive with 160 gigs. You can take it out even while the machine is on. 3.6GHz. \$2,050; hp.com



Tub TV

Casio XF-1000 >> At last! A 10-inch LCD TV that's wireless and waterproof. A base station compresses audio and video signals into MPEG2 and transmits up to 100 feet via 802.11b Wi-Fi. \$1,550; casio.co.jp



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RBRC was named "Environmental Partner of the Year" by The Home Depot in 2002.

Recycle your rechargeable batteries.

RBRC Spokesperson Richard Karn,
"Al" from TV's *Home Improvement*



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The Home Depot
RadioShack
Staples
Target

In Canada:

Bell Mobility
Canadian Tire
Future Shop
The Home Depot
RadioShack
The Sony Store
TELUS Mobility



Gentler Giant

Chevy Silverado Hybrid

>> An optional power system gets you the same 295 hp and 330 lb.-ft. of torque as the gas-only version does, plus a 10 percent jump in fuel economy. It's the first full-size hybrid truck. \$2,500 option for 2005 models; chevrolet.com



Watch and Learn

Rolleiflex Mini-Digi

>> The first twin-lens reflex digicam lets you watch the action happen through one lens—on an LCD screen on top—while the other captures the image. \$350; rolleiflexusa.com



Drop-in Digitizer

Epson Perfection 2580 Photo Scanner

>> Turn 35mm negatives into digital photos with the simple film loader on this 2,400-dpi scanner. 48-bit color. USB 2.0. \$150; epson.com

Wi-Fi Bloodhound

Chrysalis Wi-Fi Seeker >> Now you don't have to ask a clueless barista whether you're in an 802.11b hot spot; just check the LED indicator. Proprietary programming keeps it from mistaking a microwave for a wireless signal. \$30; wifiseeker.com



Handicap Helper

3M Greptile Grip Golf Glove

>> Microscopic tendrils protruding from a swath of synthetic polymer across the palm give good grip wet or dry. \$16; 3M.com



Presentation Power Tool

Luidia eBeam Interactive >> Turn any projection surface into a remote touch screen. Bluetooth sensor and stylus link with your PC, letting you control it by "drawing" on the projection. \$1,000; luidia.com



Blood Bath

Seal-On Spray

>> Gauze in a can: Micro-disbursed oxidized cellulose—a cotton derivative—in the spray encourages blood to clot quickly. \$8; seal-on.com



Sick but True

Adirondack Optics SmartScope

>> Capture your prey's last moment of life. This 1MP riflescope digital camera takes a photo when you pull the trigger and writes it to a SmartMedia card. \$1,700; adkoptics.com



A Bona Fide Camera Phone

Casio A5406CA

>> The world's first 3.2MP camera phone has 12.8MB of memory; use mini SD cards if you need more. Price not set; casio.co.jp



Nailslinger

Black & Decker 12-Volt Cordless Nailer

>> Firing two rounds per second, it's the fastest electric cordless nail gun available. A micro-processor troubleshoots jams. \$200; blackanddecker.com



Good, Clean Fun

Zap MBZ Heavy-Duty Minibike

>> The first, uh, AWD offroad electric minibike. Its power system drives twin 48-volt motors inside the hub of each wheel. \$900; zapworld.com

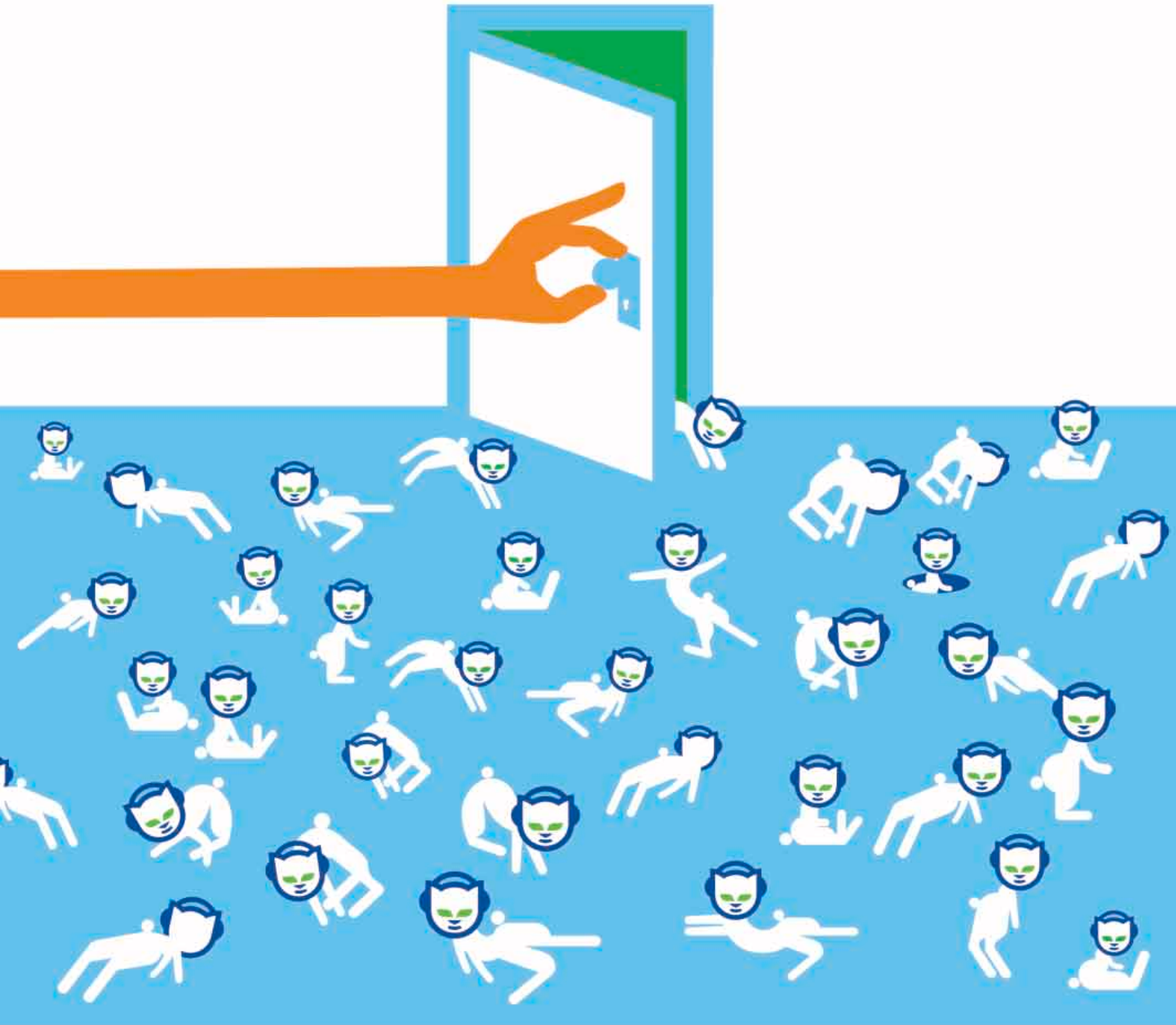
The Deep Dark

Hitachi PJTX100

>> Hitachi's new 16:9 high-definition projector cranks out 1,200 lumens, and its gamma curve adjustment allows you to set a true black without losing detail in other dark colors. \$4,000; hitachi.us



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For that Healthy Glow, Drink Radiation!

In the early 1900s, radioactive water was all the rage. Hard to believe smart people could fall for such twaddle—right?

● A CENTURY AGO RADIOACTIVITY was new, exciting and good for you—at least if you believed the people selling radium pendants for rheumatism, all-natural radon water for vigor, uranium blankets for arthritis and thorium-laced medicine for digestion (you don't even want to know about the radioactive suppositories).

Crazy, huh? Until I ran into the fascinating book *Living with Radiation, the First Hundred Years*, self-published by Paul Frame and William Kolb, I had no idea that radiation was the basis for a huge quack-medicine industry that lasted for decades and took in millions.

Today we know that exposing yourself to radiation is a bad idea. Even when radiation is used to treat cancer, its deadliness is what does the work, killing cancer cells at a slightly higher rate than normal cells.

But imagine yourself 100 years ago, before many of the first researchers studying radioactivity had died of cancer or other radiation-induced causes. Electricity had been discovered relatively recently, and it turned out to be perfectly safe in moderation, so why not radiation?

In fact, early discoveries made plenty of reasonable people think that radiation could be good for you. Natural hot springs have been used as health spas for thousands of years; even today, vacationers flock to their healing (well, maybe) waters. When scientists went around with radiation detectors, they discovered that the waters from quite a few well-known hot springs were radioactive. (Radon gas produced by the decay of thorium and uranium

deep in the earth permeates the water at many natural hot springs.)

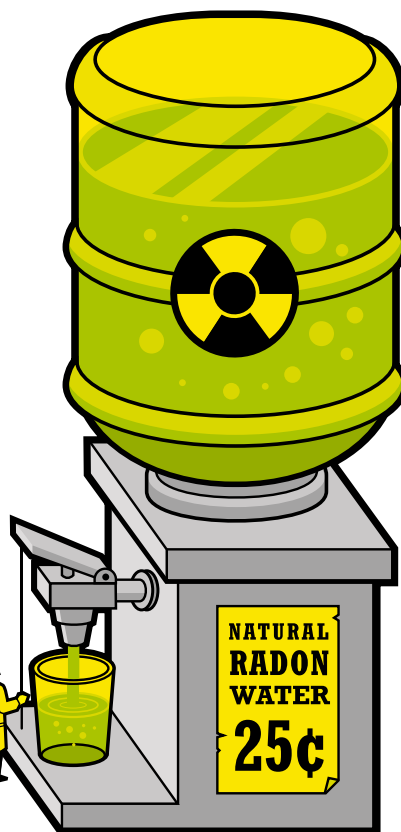
Since no one really knew what made them healthful, the springs' radioactivity was as good a guess as any. Entrepreneurs started bottling the water and selling it as "Radon Water." But rivals soon pointed out a problem: Radon's half-life is just 3.82 days. By the time the bottle reached the customer, most of the radiation would be gone.

You might go so far as to say that Radon Water was a rip-off, which is exactly the pitch the Radium Ore Revigator company used to sell its "better," "more scientific" product: a watercooler lined with a serious amount of carnotite, an ore of uranium and radium that undergoes radioactive decay, yielding



radon gas. Storing any water in this cooler overnight would give you fresh, potent, invigorating radon water to drink by morning. Unfortunately for those who used them, Revigators actually worked. (Today, of course, we run as fast as we can from radon; ridding basements of it is a big business.)

Many of the radioactive products marketed at the time, such as uranium blankets, contained radioactive materials, but at such low levels that they probably did little harm to consumers.



But over time, companies started producing ever more powerful devices, most of them based on radium, the element with the strongest marketing appeal. The supremely scary Radi-endocrinator was a 2-inch by 3-inch case that contained paper infused with 250 microcuries of radium, enough to illuminate a fluorescent screen placed near it. It was meant to be placed over—the very thought makes me shudder—the endocrine glands.

As the industry developed, it gave

GRAB LIFE BY THE HORNS



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BY U-HAUL®

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ALL-NEW DODGE MAGNUM RT. OPEN IT UP FROM EITHER END. Introducing the most powerful production vehicle under \$30,000,* the all-new 2005 Dodge Magnum RT. Open it up and you'll find the power of a 340-horsepower HEMI® V8 engine and the performance of world-class ride and handling. Lift the unique access liftgate, and you'll find more cargo space and comfort than you ever thought possible. Dodge Magnum. Either way you open it, it's perfect for you. Visit dodge.com or call 800-4ADODGE.

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birth to the inevitable wave of fraudulent products—fraudulent in the sense that they did not emit the high levels of radiation they claimed to. This led to a couple of the more surreal aspects of the whole episode: advertisements that positively guaranteed that a company's products exposed you to the full dose of radiation promised, and instances of the government shutting down companies selling perfectly safe phony products instead of the real (deadly) items they claimed to be offering.

For example, the Bailey Radium Laboratories of East Orange, New Jersey, offered \$1,000 to anyone who could prove that its "Certified Radioactive Water," sold under the brand name Radithor, did not contain the large amount of radium and thorium it claimed to. Alas, Radithor was the real thing: No one ever claimed the prize. But Radithor did claim at least one life, that of the well-known industrialist, playboy and three-bottle-a-day Radithor user Eben Byers. Byers's gruesome death in 1932 inspired the *Wall Street Journal* headline "The Radium Water Worked Fine until His Jaw Came Off."

Byers's death also prompted the newly formed FDA to crack down on radioactive health products, insisting on proof of their safety and effectiveness. Since they were neither, this had the effect of putting manufacturers out of business. Although low-radioactivity devices continued to slip through regulatory cracks until well into the

latest discoveries and promote them to the desperate-for-a-cure market, regardless of how remote the connection between the discovery and any likely health benefits might be. Irradiating yourself in the hope of feeling better

see if it has a familiar ring:

Is radio-activity dangerous to the health? Most everyone offers this questions [sic] because it is only natural to regard this as a drug or medicine. The answer is that radio-activity is not a medicine or drug, but a natural element of water, and that since practically all spring and well water that Nature herself gives for drinking purposes contain this highly effective beneficial element, it is but common sense to restore it to water that has lost it just as we restore oxygen to a stuffy room by opening a window. . . . The United States Government says that the radio-activity of natural water is never strong enough to be injurious.

In short, (1) what we're selling is "natural," unlike those potent medicines your doctor prescribes; (2) maybe you are not getting enough of this natural substance; and (3) the government hasn't stopped us (yet). Remember,



PATENT NONSENSE A few items from William Kolb's extensive collection of strangely compelling radioactive nostrums (clockwise from top): Radione tablets, for energy; the Zimmer Laboratory Radium Emanator, which was designed to be immersed in a quart of water; and the Revigator watercooler, which, unfortunately, worked only too well.

Byers's gruesome death inspired the *Wall Street Journal* headline "The Radium Water Worked Fine until His Jaw Came Off."

1960s, the era of dangerously radioactive quack cures essentially went to the grave with Eben Byers.

The radium mania was a crazy little episode in the world of medicine, but it was not at all out of the ordinary. Pain and suffering have always helped foster an uncritical market for remedies and preventatives. Quacks and profiteers are quick to pick up on the

was no nuttier than, say, drinking a few teaspoons of plain water as medicine, which is called homeopathy and is extremely popular today.

These fads, old and new, tend to make remarkably similar claims, using the same arguments and marketing methods. Take a look, for instance, at the following passage, from a 1928 Radium-ore Revigator brochure, and

they're talking about radon gas.

You could find a paragraph almost identical to this one in any health food store today. Here's an example taken from the Web site of a more contemporary product designed to help your, um, vigor:

Is Nymphomax safe?

Because Nymphomax is an all natural nutritional supplement containing only the finest botanicals, there are no harmful side effects when taken as directed. Nymphomax is not a pharmaceutical drug and contains none of the synthetic chemicals found in prescription medications. It is a safe alternative to prescription drugs, which can sometimes have serious side effects.

Now, I'm not saying herbal medicines are as harmful as radiation, simply that promoting them as "all natural" tells you absolutely nothing about whether they are safe, effective, both or neither. What matters is what's in

the pill, not how it got there. There may be all kinds of herbal medicines that are safe and effective—just don't expect the industry, or the government, to tell you which ones.

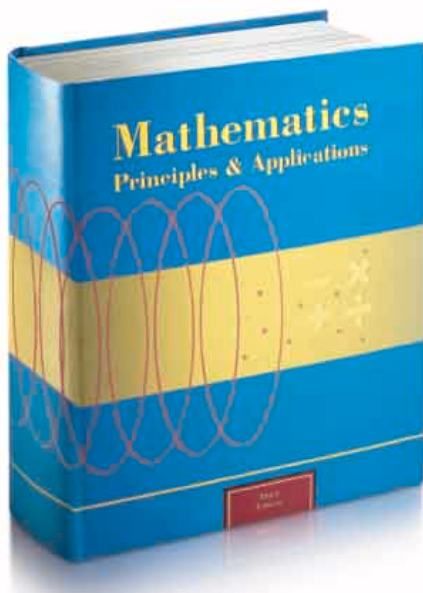
Amazingly, current federal law (the Dietary Supplement Health and Education Act of 1994) specifically orders the FDA to keep its hands off virtually all herbal medicines, preventing it from regulating the claims, ingredients or safety of these preparations and forbidding it to require the tracking of side effects and deaths caused by them. And although the FDA banned ephedra after several high-profile deaths, it will probably take many more such tragedies before the law is changed to allow the agency to clamp down on other dangerous products.

Radon Water was harmless because it contained nothing, the radiation having vanished before it reached customers. Amusingly, this has an exact

analogue in modern homeopathic remedies. Homeopathy "works" by dilution: Preparations of powerful substances are diluted, then diluted again and again and again until there is almost no chance that even a single molecule of the original substance remains in the final "medicine." These nostrums are sold to the public at top dollar, labeled with their original starting-point ingredients just as if they still contained any of them.

So don't for a minute think that we're all smarter and more modern than those idiots eating radium 100 years ago: Homeopathy is a huge industry today, and it is every bit as nutty. Once people suspend their critical thinking skills and go for hope over reality, the sky's the limit in silly and dangerous medicine. ■

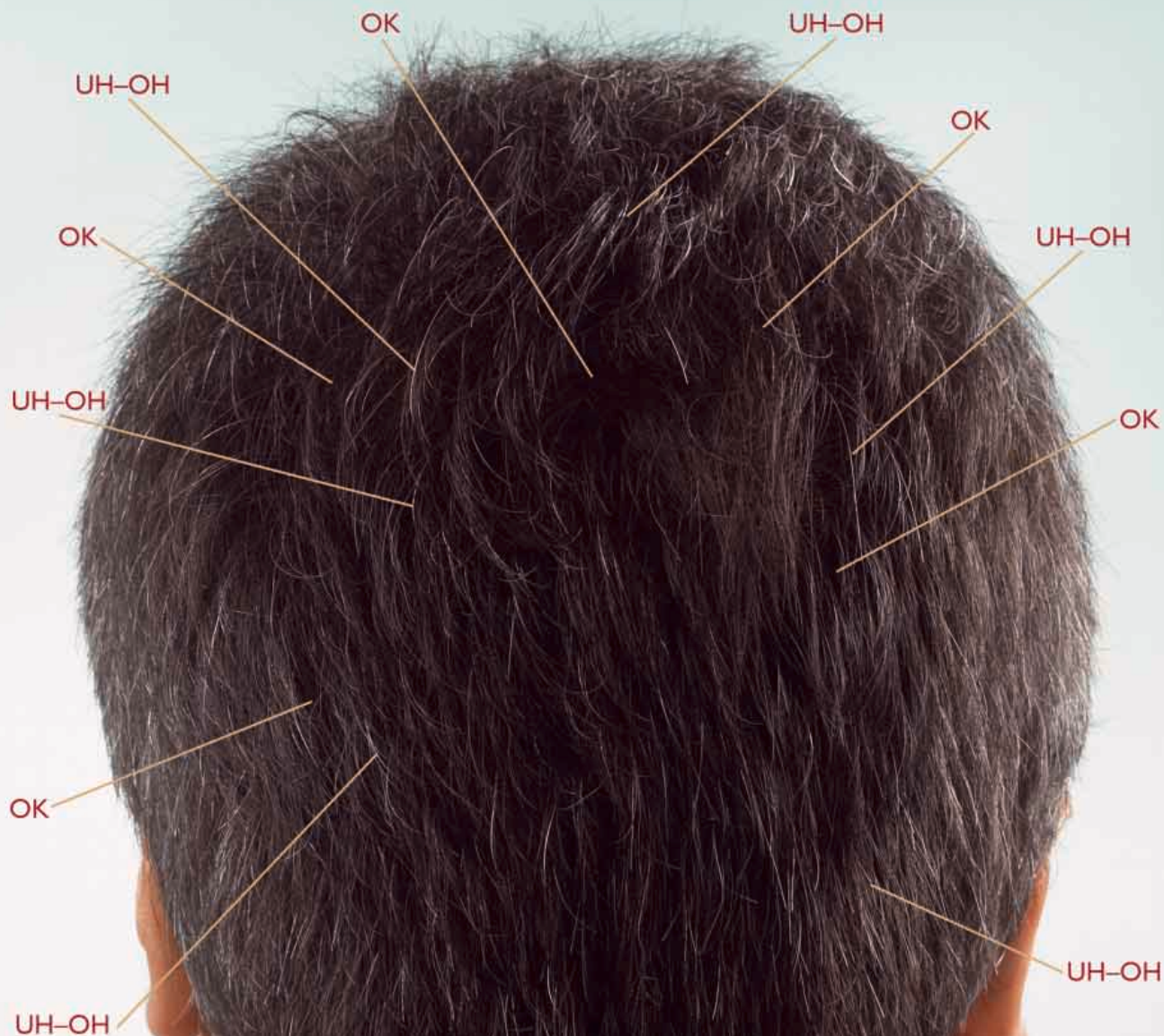
To order a copy of Living With Radiation, go to theodoregray.com/LWR.html.



Expand your mind. Well, enough of that.

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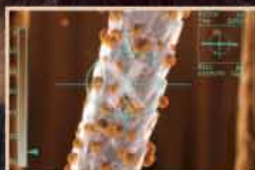




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NASA punts a plucky probe toward Mercury.

THE NEW ÜBERMATERIAL

Bend it. Burn it. Metal Rubber bounces back.

ANTI-TERROR PATENTS

New gadgets from independent inventors.

FUTURE NEWS The 2024 Olympic Games.

Discoveries, Advances & Debates in Science and the World

NATURAL RESOURCES

HOW LONG WILL THE OIL AGE LAST?

Geologists say the end is nigh. New recovery tech may tell a different story.

▶ Quick, how many years will it be before the world runs out of oil? Don't know? Join the club. Actually, choose one of several clubs, each of which vehemently disagrees with the others on how much usable crude is left on the earth. The question is far from an academic exercise: This year oil hit a near record-high \$40 a barrel, and Royal Dutch/Shell Group down-

graded its reserves by 4.5 billion barrels.

While consumers pay for perceived shortages at the pump, scientists and economists struggle to reach consensus over "proven oil reserves," or how much oil you can realistically mine before recovery costs outstrip profits. Economist Leonardo Maugeri of Italian energy company Eni fired up the

debate this May with an essay in *Science* that accused the "oil doomsters" of crying wolf.

Chief among the pessimists is the Association for the Study of Peak Oil, a group of European scientists who estimate that maximum oil production around the globe will peak in 2008 as demand rises from developing economies such as China. "If you squeezed all the oil in Iraq into a single bottle, you could fill four glasses, with the world consuming one glass of oil each year," says physicist and ASPO president Kjell Aleklett. "We've consumed nine bottles since oil was discovered, and we have another 9 or 10 in the refrigerator. How many more are there? Some say five or six, but we say three."

Others believe, like Maugeri, that the number of glasses is virtually limitless. John Felmy, chief economist at the American Petroleum Institute, argues that peak oil-production estimates are so far off that for all practical purposes we might as well act as if oil will flow forever. "Ever since oil was first harvested in the 1800s, people

SHELLING OUT: THIS SPRING, CLAIMS OF OIL SHORTAGES FUELED NEAR-RECORD HIGH GAS PRICES IN LOS ANGELES.



DAVID McNEW/GETTY IMAGES

have said we'd run out of the stuff," Felmy says. In the 1880s a Standard Oil executive sold off shares in the company out of fear that its reserves were close to drying up. The Club of Rome, a non-profit global think tank, said in the 1970s that we'd hit peak oil in 2003. It didn't happen.

If there is an end to the debate, advanced oil-recovery technologies will most likely find it. A new seismic survey technique, for instance, sends sound waves of varying frequencies thousands of meters

"EVER SINCE OIL WAS FIRST HARVESTED IN THE 1800s, PEOPLE HAVE SAID WE'D RUN OUT OF THE STUFF," ECONOMIST JOHN FELMY SAYS. "IT'S NEVER HAPPENED."

belowground. Microphones arrayed aboveground record the reflected signals, and computer software models a 3-D portrait of possible oil hot spots. The surveys have now added a fourth dimension, creating a time-lapse simulation of fluid movements.

Companies are also finding sophisticated ways to mine more oil from existing wells. Flexible, coiled-tube drills that carve out horizontal side paths are a marked improvement over conventional, rigid drills that move only straight down. Using such technology, companies hope to soon harvest 50 to 60 percent of oil from existing wells, up from today's 35 percent.

Biotechnology, too, is keeping the black gold flowing. University of Alberta scientists are searching for microorganisms that could dilute viscous, hard-to-recover oil and make it flow more freely.

"Technology can help push peak oil production further and further out," says Satish Pai, vice president of oilfield technologies for Schlumberger Limited. But only time will tell if it's enough.

—KEVIN KELLEHER

INTERPLANETARY EXPLORATION

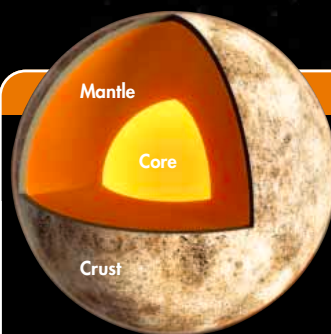
MERCURY OR BUST

Messenger's wild and risky ride to the innermost planet.

If you haven't perfected your tan yet this summer, have we got a spot for you! A place where the sun shines 11 times as bright as on Earth, doesn't set for 4,000 hours, and produces 800°F temperatures. There's much to explore, since this exotic destination is mostly unmapped. If you get lost, a compass will orient you, thanks to an Earth-like magnetic field.

We're talking, of course, about Mercury. Despite the sales pitch, only one craft has ever visited the tiny planet: *Mariner 10*, a flyby probe, that mapped just 45 percent of Mercury's surface back in 1974. Thirty years later a follow-up craft is finally on the way to pick up where *Mariner 10* left off. NASA's *Messenger* orbiter, set to launch in July, will delve into the planet's many mysteries, among them a dense iron core and a magnetic field whose existence scientists have yet to explain.

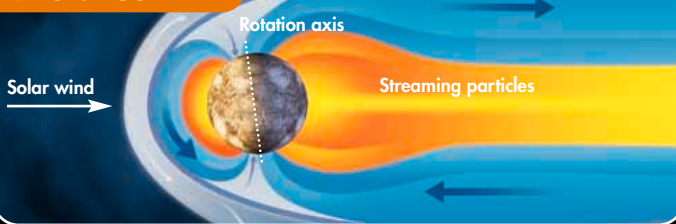
While *Messenger's* scientific objectives are fairly straightforward, its flight path is anything but (see box on facing page). Slipping a probe into Mercury's orbit is a dicey and technologically challenging feat, says the mission's principal investigator, Sean Solomon. The orbiter will speed toward the planet at approximately 15 kilometers a second. "The challenge is to slow the spacecraft prior to orbit insertion," Solomon says. Otherwise it will rip past Mercury and fall into orbit around the Sun. To hit the brakes, *Messenger* will fly once by Earth, twice by Venus and three times by Mercury, using each of the six planetary passes to eventually slow into a stable orbit around Mercury in 2011. —WILLIAM SPEED WEED



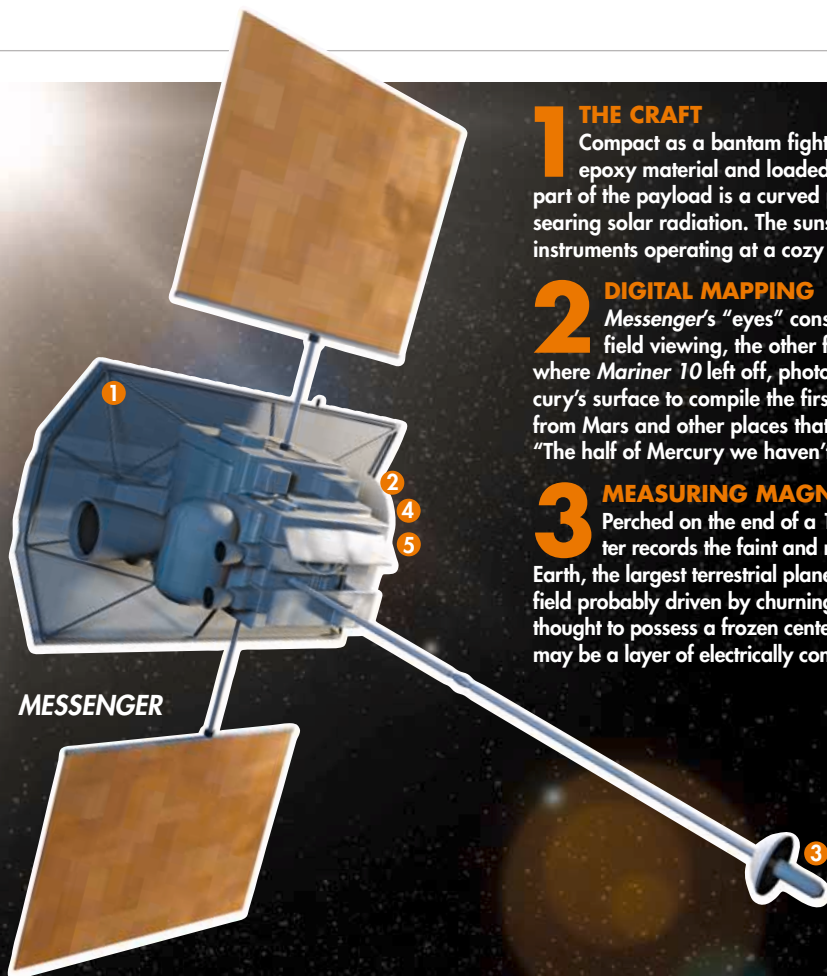
CORE MYSTERIES

Messenger should find out if Mercury's core has a molten outer layer, like Earth. Originally, scientists thought the core was frozen solid, but *Mariner 10* detected a weak magnetic field. Blasted by solar winds, the field bends around the planet, forming a region of charged particles called a magnetosphere.

MAGNETOSPHERE



GARRY MARSHALL



MESSENGER

1 THE CRAFT

Compact as a bantam fighter, *Messenger* is made of lightweight graphite-epoxy material and loaded with seven scientific instruments. A critical part of the payload is a curved piece of ceramic that shields the probe from searing solar radiation. The sunshade will absorb the Sun's heat and keep the instruments operating at a cozy 70°F.

2 DIGITAL MAPPING

Messenger's "eyes" consist of a pair of digital cameras, one for wide-field viewing, the other for close-up detail. These cameras will pick up where *Mariner 10* left off, photographing the remaining 55 percent of Mercury's surface to compile the first complete map of the planet. "We've learned from Mars and other places that planets aren't symmetrical," Solomon says. "The half of Mercury we haven't seen could surprise us."

3 MEASURING MAGNETISM

Perched on the end of a 12-foot boom, the alarm clock-size magnetometer records the faint and mysterious magnetic field surrounding Mercury. Earth, the largest terrestrial planet, has a similar but much stronger magnetic field probably driven by churning molten liquid in its outer core. Mercury is thought to possess a frozen center, but the magnetic field suggests that there may be a layer of electrically conductive fluid sloshing around the outer core.

4 SOLID OR LIQUID?

A laser altimeter bounces light off the surface and maps the topography of the planet. Over the course of several Mercury years (each lasting just 88 Earth days), the instrument will also detect a tiny wobble in the planet's rotation, called libration, which should tell scientists whether Mercury's large core is solid or in fact contains liquid.

5 HUNTING FOR IRON AND ICE

A suite of light analyzers will take stock of Mercury's surface chemistry and very faint atmosphere. Because of the planet's high density (second only to that of Earth), scientists believe it's composed of roughly 66 percent iron, but neither *Mariner 10* nor ground-based observations have found substantial amounts of iron on the surface. The spectrometers will hunt for surface iron and evidence of ice hidden in Sun-shaded craters at the planet's poles.

MERCURY

THE SCENIC ROUTE

For an ordinary flyby mission, the trip to Mercury takes just a few months. The *Messenger* mission will take much longer because the probe must change its speed, as well as the shape and tilt of its orbit around the Sun, to slip into Mercury's orbit. After launch, *Messenger* will swing by Earth in 2005, then Venus twice, plus three tours past Mercury. Each pass reduces its speed in preparation for a 2011 arrival at Mercury.

PLANET KEY

- EARTH
- VENUS
- MERCURY



MATERIALS SCIENCE

A LIMBER FUTURE

"Smart skin" holds promise for morphing wings and wearable computers.

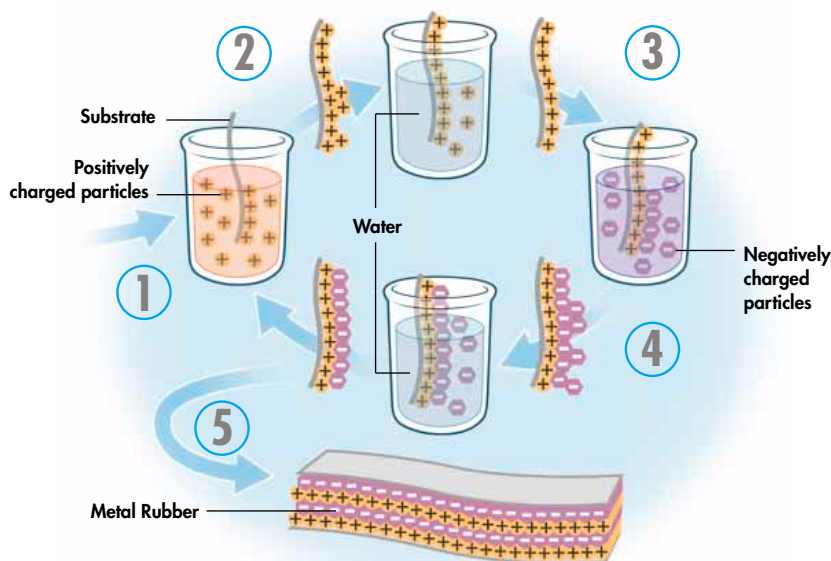
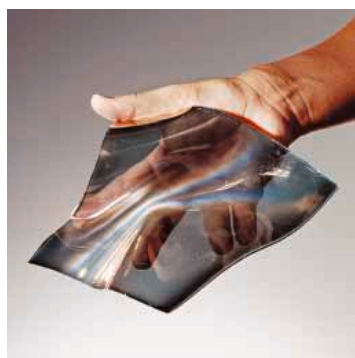
▶ Terrible, horrible things can be done to this millimeters-thick patch of shimmering material crafted by chemists at NanoSonic in Blacksburg, Virginia. Twist it, stretch it double, fry it to 200°C, douse it with jet fuel—the stuff survives. After the torment, it snaps like rubber back to its original shape, all the while conducting electricity like solid metal. "Any other material would lose its conductivity," says Jennifer Hoyt Lalli, NanoSonic's director of nanocomposites.

The abused substance is called Metal Rubber, and, according to

NanoSonic, its particular properties make it unique in the world of material chemistry. As a result, the company's small office has been flooded with calls from Fortune 500 companies and government agencies eager to test Metal Rubber's use in everything from artificial muscles to smart clothes to shape-shifting airplane wings.

At this stage, however, NanoSonic is busy meeting the demand for its 12-inch-by-12-inch samples, which take custom-built robots up to three days to create. That's speedy, if you consider that Metal Rubber, a product

DESPITE THE NAME, METAL RUBBER, ABOVE, "CONTAINS JUST PARTS PER MILLION OF METAL YET CONDUCTS ELECTRICITY NEARLY AS WELL AS A SOLID METAL," SAYS POLYMER CHEMIST JENNIFER HOYT LALLI (LEFT). ITS SECRET? CHEMICAL BONDS THAT STRETCH APART BUT DON'T BREAK.



MAKING METAL RUBBER FROM SCRATCH

Dip charged substrate into container of positively charged water-based solution (1). Rinse substrate in water to remove unbound particles (2). Dip substrate into negatively charged solution (3). Rinse and repeat (4, 5).

of nanotechnology, must be fabricated molecule by molecule.

The manufacturing process, called electrostatic self-assembly, starts with two buckets of water-based solutions—one filled with positively charged metallic ions, the other with oppositely charged elastic polymers. The robot dips a charged substrate (glass, for example) alternately from one bucket to the next. The dipping slowly builds up tight, organized layers of molecules, bonded firmly by opposing charges. Afterward the substrate is removed, leaving a freestanding sheet of Metal Rubber.

With investor interest booming, Metal Rubber could make its commercial debut within a year or so. Although shape-shifting aircraft wings and sensory robotic gloves are on the horizon, Metal Rubber will probably appear first in more humble, practical roles. Abuse-resistant flexible circuits and wires, for instance, could allow you to do terrible, horrible things to your portable electronics—consequence-free.

—LAURA ALLEN



This is really high.

297
Total Cholesterol

This is high.

Important information:

LIPITOR® (atorvastatin calcium) is a prescription drug. It is used with a low-fat diet to lower cholesterol.

LIPITOR is not for everyone. It is not for those with liver problems. And it is not for women who are nursing, pregnant, or may get pregnant. It has not been shown to prevent heart disease or heart attacks.

If you take LIPITOR, tell your doctor if you feel any new muscle pain or weakness. This could be a sign of serious muscle side effects. Tell your doctor about all the medicines you take. This may help avoid serious drug interactions. Your doctor should do blood tests to check your liver function before and during treatment and may adjust your dose. The most common side effects are gas, constipation, stomach pain, and heartburn. They tend to be mild and often go away.

Please see additional important information on next page.

Why not help reduce one of your risk factors for heart disease. Like high cholesterol, for example. You can eat right. You can exercise. But for many people diet and exercise may not be enough. In fact, 2 out of 3 adults with high cholesterol may need medicine. The good news is that adding LIPITOR can help. It can help lower your total cholesterol 29% to 45%*. And it can help lower your bad cholesterol 39% to 60%*. (*The average effect depends on the dose.) Talk to your doctor today. Find out if LIPITOR is right for you. And why it is the most prescribed medicine of its kind. Call us at 1-888-LIPITOR or find us on the web at www.lipitor.com.

Go **Red**
for women



LIPITOR
atorvastatin calcium
tablets

FOR CHOLESTEROL®

LIPITOR® (Atorvastatin Calcium) Tablets

Brief Summary of Prescribing Information

CONTRAINDICATIONS: Active liver disease or unexplained persistent elevations of serum transaminases. Hypersensitivity to any component of this medication. **Pregnancy and Lactation** — Atherosclerosis is a chronic process and discontinuation of lipid-lowering drugs during pregnancy should have little impact on the outcome of long-term therapy of primary hypercholesterolemia. Cholesterol and other products of cholesterol biosynthesis are essential components for fetal development (including synthesis of steroids and cell membranes). Since HMG-CoA reductase inhibitors decrease cholesterol synthesis and possibly the synthesis of other biologically active substances derived from cholesterol, they may cause fetal harm when administered to pregnant women. Therefore, HMG-CoA reductase inhibitors are contraindicated during pregnancy and in nursing mothers. ATORVASTATIN SHOULD BE ADMINISTERED TO WOMEN OF CHILDBEARING AGE ONLY WHEN SUCH PATIENTS ARE HIGHLY UNLIKELY TO CONCEIVE AND HAVE BEEN INFORMED OF THE POTENTIAL HAZARDS. If the patient becomes pregnant while taking this drug, therapy should be discontinued and the patient apprised of the potential hazard to the fetus.

WARNINGS: Liver Dysfunction — HMG-CoA reductase inhibitors, like some other lipid-lowering therapies, have been associated with biochemical abnormalities of liver function. **Persistent elevations (>3 times the upper limit of normal [ULN] occurring on 2 or more occasions) in serum transaminases occurred in 0.7% of patients who received atorvastatin in clinical trials. The incidence of these abnormalities was 0.2%, 0.2%, 0.6%, and 2.3% for 10, 20, 40, and 80 mg, respectively.** One patient in clinical trials developed jaundice. Increases in liver function tests (LFT) in other patients were not associated with jaundice or other clinical signs or symptoms. Upon dose reduction, drug interruption, or discontinuation, transaminase levels returned to or near pretreatment levels without sequelae. Eighteen of 30 patients with persistent LFT elevations continued treatment with a reduced dose of atorvastatin. It is recommended that liver function tests be performed prior to and at 12 weeks following both the initiation of therapy and any elevation of dose, and periodically (eg, semiannually) thereafter. Liver enzyme changes generally occur in the first 3 months of treatment with atorvastatin. Patients who develop increased transaminase levels should be monitored until the abnormalities resolve. Should an increase in ALT or AST of >3 times ULN persist, reduction of dose or withdrawal of atorvastatin is recommended. Atorvastatin should be used with caution in patients who consume substantial quantities of alcohol and/or have a history of liver disease. Active liver disease or unexplained persistent transaminase elevations are contraindications to the use of atorvastatin (see CONTRAINDICATIONS). **Skeletal Muscle** — Rare cases of rhabdomyolysis with acute renal failure secondary to myoglobinuria have been reported with atorvastatin and with other drugs in this class. Uncomplicated myalgia has been reported in atorvastatin-treated patients (see ADVERSE REACTIONS). Myopathy, defined as muscle aches or muscle weakness in conjunction with increases in creatine phosphokinase (CPK) values >10 times ULN, should be considered in any patient with diffuse myalgia, muscle tenderness or weakness, and/or marked elevation of CPK. Patients should be advised to report promptly unexplained muscle pain, tenderness or weakness, particularly if accompanied by malaise or fever. Atorvastatin therapy should be discontinued if markedly elevated CPK levels occur or myopathy is diagnosed or suspected. The risk of myopathy during treatment with drugs in this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, erythromycin, niacin, or azole antifungals. Physicians considering combined therapy with atorvastatin and fibric acid derivatives, erythromycin, immunosuppressive drugs, azole antifungals, or lipid-lowering doses of niacin should carefully weigh the potential benefits and risks and should carefully monitor patients for any signs or symptoms of muscle pain, tenderness, or weakness, particularly during the initial months of therapy and during any periods of upward dosage titration of either drug. Periodic creatine phosphokinase (CPK) determinations may be considered in such situations, but there is no assurance that such monitoring will prevent the occurrence of severe myopathy. **Atorvastatin therapy should be temporarily withheld or discontinued in any patient with an acute, serious condition suggestive of a myopathy or having a risk factor predisposing to the development of renal failure secondary to rhabdomyolysis (eg, severe acute infection, hypotension, major surgery, trauma, severe metabolic, endocrine and electrolyte disorders, and uncontrolled seizures).**

PRECAUTIONS: General — Before instituting therapy with atorvastatin, an attempt should be made to control hypercholesterolemia with appropriate diet, exercise, and weight reduction in obese patients, and to treat other underlying medical problems (see INDICATIONS AND USAGE in full prescribing information). **Information for Patients** — Patients should be advised to report promptly unexplained muscle pain, tenderness, or weakness, particularly if accompanied by malaise or fever. **Drug Interactions** — The risk of myopathy during treatment with drugs of this class is increased with concurrent administration of cyclosporine, fibric acid derivatives, niacin (nicotinic acid), erythromycin, azole antifungals (see WARNINGS, Skeletal Muscle). **Atorvastatin** When atorvastatin and Maalox® TC suspension were coadministered, plasma concentrations of atorvastatin decreased approximately 35%. However, LDL-C reduction was not altered. **Antipyretics:** Because atorvastatin does not affect the pharmacokinetics of antipyretics, interactions with other drugs metabolized via the same cytochrome isozymes are not expected. **Colestipol:** Plasma concentrations of atorvastatin decreased approximately 25% when colestipol and atorvastatin were coadministered. However, LDL-C reduction was greater when atorvastatin and colestipol were coadministered than when either drug was given alone. **Cimetidine:** Atorvastatin plasma concentrations and LDL-C reduction were not altered by coadministration of cimetidine. **Digoxin:** When multiple doses of atorvastatin and digoxin were coadministered, steady-state plasma digoxin concentrations increased by approximately 20%. Patients taking digoxin should be monitored appropriately. **Erythromycin:** In healthy individuals, plasma concentrations of atorvastatin increased approximately 40% with coadministration of atorvastatin and erythromycin, a known inhibitor of cytochrome P450 3A4 (see WARNINGS, Skeletal Muscle). **Oral Contraceptives:** Coadministration of atorvastatin and an oral contraceptive increased AUC values for norethindrone and ethinyl estradiol by approximately 30% and 20%. These increases should be considered when selecting an oral contraceptive for a woman taking atorvastatin.

Warfarin: Atorvastatin had no clinically significant effect on prothrombin time when administered to patients receiving chronic warfarin treatment. **Endocrine Function** — HMG-CoA reductase inhibitors interfere with cholesterol synthesis and theoretically might blunt adrenal and/or gonadal steroid production. Clinical studies have shown that atorvastatin does not reduce basal plasma cortisol concentration or impair adrenal reserve. The effects of HMG-CoA reductase inhibitors on male fertility have not been studied in adequate numbers of patients. The effects, if any, on the pituitary-gonadal axis in premenopausal women are unknown. Caution should be exercised if HMG-CoA reductase inhibitors are administered concomitantly with drugs that may decrease the levels or activity of endogenous steroid hormones, such as ketoconazole, spironolactone, and cimetidine. **CNS Toxicity** — Brain hemorrhage was seen in a female dog treated for 3 months at 120 mg/kg/day. Brain hemorrhage and optic nerve vacuolation were seen in another female dog that was sacrificed in moribund condition after 11 weeks of escalating doses up to 280 mg/kg/day. The 120 mg/kg dose resulted in a systemic exposure approximately 16 times the human plasma area-under-the-curve (AUC, 0-24 hours) based on the maximum human dose of 80 mg/day. A single tonic convulsion was seen in each of 2 male dogs (one treated at 10 mg/kg/day and one at 120 mg/kg/day) in a 2-year study. No CNS lesions have been observed in mice after chronic treatment for up to 2 years at doses up to 400 mg/kg/day or in rats at doses up to 100 mg/kg/day. These doses were 6 to 11 times (mouse) and 8 to 16 times (rat) the human AUC (0-24) based on the maximum recommended human dose of 80 mg/day. CNS vascular lesions, characterized by perivascular hemorrhages, edema, and mononuclear cell infiltration of perivascular spaces, have been observed in dogs treated with other members of this class. A chemically similar drug in this class produced optic nerve degeneration (Wallierian degeneration of retinogeniculate fibers) in clinically normal dogs in a dose-dependent fashion at a dose that produced plasma drug levels about 30 times higher than the mean drug level in humans taking the highest recommended dose. **Carcinogenesis, Mutagenesis, Impairment of Fertility** — In a 2-year carcinogenicity study in rats at dose levels of 10, 30, and 100 mg/kg/day, 2 rare tumors were found in muscle in high-dose females: in one, there was a rhabdomyosarcoma and, in another, there was a fibrosarcoma. This dose represents a plasma AUC (0-24) value of approximately 16 times the mean human plasma drug exposure after an 80 mg oral dose. A 2-year carcinogenicity study in mice given 100, 200, or 400 mg/kg/day resulted in a significant increase in liver adenomas in high-dose males and liver carcinomas in high-dose females. These findings occurred at plasma AUC (0-24) values of approximately 6 times the mean human plasma drug exposure after an 80 mg oral dose. *In vitro*, atorvastatin was not mutagenic or clastogenic in the following tests with and without metabolic activation: the Ames test with *Salmonella typhimurium* and *Escherichia coli*, the HGPRT forward mutation assay in Chinese hamster lung cells, and the chromosomal aberration assay in Chinese hamster lung cells. Atorvastatin was negative in the *in vivo* mouse micronucleus test. Studies in rats performed at doses up to 175 mg/kg (15 times the human exposure) produced no changes in fertility. There was aplasia and aspermia in the epididymus of 2 of 10 rats treated with 100 mg/kg/day of atorvastatin for 3 months (16 times the human AUC at the 80 mg dose); testis weights were significantly lower at 30 and 100 mg/kg and epididymal weight was lower at 100 mg/kg. Male rats given 100 mg/kg/day for 11 weeks prior to mating had decreased sperm motility, sperm head concentration, and increased abnormal sperm. Atorvastatin caused no adverse effects on semen parameters, or reproductive organ histopathology in dogs given doses of 10, 40, or 120 mg/kg for two years. **Pregnancy** — **Pregnancy Category X:** See CONTRAINDICATIONS. Safety in pregnant women has not been established. Atorvastatin crosses the rat placenta and reaches a level in fetal liver equivalent to that of maternal plasma. Atorvastatin was not teratogenic in rats at doses up to 300 mg/kg/day or in rabbits at doses up to 100 mg/kg/day. These doses resulted in multiples of about 30 times (rat) or 20 times (rabbit) the human exposure based on surface area (mg/m²). In a study in rats given 20, 100, or 225 mg/kg/day, from gestation day 7 through to lactation day 21 (weaning), there was decreased pup survival at birth, neonate, weaning, and maturity in pups of mothers dosed with 225 mg/kg/day. Body weight was decreased on days 4 and 21 in pups of mothers dosed at 100 mg/kg/day; pup body weight was decreased at birth and at days 4, 21, and 91 at 225 mg/kg/day. Pup development was delayed (rotorod performance at 100 mg/kg/day and acoustic startle at 225 mg/kg/day; pinnae detachment and eye opening at 225 mg/kg/day). These doses correspond to 6 times 100

mg/kg) and 22 times (225 mg/kg) the human AUC at 80 mg/day. Rare reports of congenital anomalies have been received following intrauterine exposure to HMG-CoA reductase inhibitors. There has been one report of severe congenital bony deformity, tracheo-esophageal fistula, and anal atresia (VATER association) in a baby born to a woman who took lovastatin with dextroamphetamine sulfate during the first trimester of pregnancy. LIPITOR should be administered to women of child-bearing potential only when such patients are highly unlikely to conceive and have been informed of the potential hazards. If the woman becomes pregnant while taking LIPITOR, it should be discontinued and the patient advised again as to the potential hazards to the fetus. **Nursing Mothers** — Nursing rat pups had plasma and liver drug levels of 50% and 40%, respectively, of that in their mother's milk. Because of the potential for adverse reactions in nursing infants, women taking LIPITOR should not breast-feed (see CONTRAINDICATIONS). **Pediatric Use** — Safety and effectiveness in patients 10-17 years of age with heterozygous familial hypercholesterolemia have been evaluated in a controlled clinical trial of 6 months duration in adolescent boys and postmenarcheal girls. Patients treated with LIPITOR had an adverse experience profile generally similar to that of patients treated with placebo, the most common adverse experiences observed in both groups, regardless of causality assessment, were infections. **Doses greater than 20 mg have not been studied in this patient population.** In this limited controlled study, there was no detectable effect on growth or sexual maturation in boys or on menstrual cycle length in girls (see CLINICAL PHARMACOLOGY, Clinical Studies section in full prescribing information). **ADVERSE REACTIONS, Pediatric Patients** (ages 10-17 years); and **DOSAGE AND ADMINISTRATION, Heterozygous Familial Hypercholesterolemia in Pediatric Patients** (10-17 years of age) in full prescribing information. Adolescent females should be counseled on appropriate contraceptive methods while on LIPITOR therapy (see CONTRAINDICATIONS and PRECAUTIONS, Pregnancy). LIPITOR has not been studied in controlled clinical trials involving pre-pubertal patients or patients younger than 10 years of age. Clinical efficacy with doses up to 80 mg/day for 1 year have been evaluated in an uncontrolled study of patients with homozygous FH including 8 pediatric patients (see CLINICAL PHARMACOLOGY, Clinical Studies: Homozygous Familial Hypercholesterolemia in full prescribing information). **Geriatric Use** — The safety and efficacy of atorvastatin (10-80 mg) in the geriatric population (>65 years of age) was evaluated in the ACCESS study. In this 54-week open-label trial, 1,958 patients initiated therapy with atorvastatin 10 mg. Of these, 835 were elderly (>65 years) and 1,123 were non-elderly. The mean change in LDL-C from baseline after 6 weeks of treatment with atorvastatin 10 mg was -38.2% in the elderly patients versus -34.6% in the non-elderly group. The rates of discontinuation due to adverse events were similar between the two age groups. There were no differences in clinically relevant laboratory abnormalities between the age groups.

ADVERSE REACTIONS: LIPITOR is generally well-tolerated. Adverse reactions have usually been mild and transient. In controlled clinical studies of 2502 patients, <2% of patients were discontinued due to adverse experiences attributable to atorvastatin. The most frequent adverse events thought to be related to atorvastatin were constipation, flatulence, dyspepsia, and abdominal pain. **Clinical Adverse Experiences** — Adverse experiences reported in >2% of patients in placebo-controlled clinical studies of atorvastatin, regardless of causality assessment, are shown in the following table.

Adverse Events in Placebo-Controlled Studies (% of Patients)					
BODY SYSTEM Adverse Event	Placebo N = 270	Atorvastatin 10 mg N = 863	Atorvastatin 20 mg N = 36	Atorvastatin 40 mg N = 79	Atorvastatin 80 mg N = 94
BODY AS A WHOLE					
Infection	10.0	10.3	2.8	10.1	7.4
Headache	7.0	5.4	16.7	2.5	6.4
Accidental Injury	3.7	4.2	0.0	1.3	3.2
Flu Syndrome	1.9	2.2	0.0	2.5	3.2
Abdominal Pain	0.7	2.8	0.0	3.8	2.1
Back Pain	3.0	2.8	0.0	3.8	1.1
Allergic Reaction	2.6	0.9	2.8	1.3	0.0
Asthenia	1.9	2.2	0.0	3.8	0.0
DIGESTIVE SYSTEM					
Constipation	1.8	2.1	0.0	2.5	1.1
Diarrhea	1.5	2.7	0.0	3.8	5.3
Dyspepsia	4.1	2.3	2.8	1.3	2.1
Flatulence	3.3	2.1	2.8	1.3	1.1
RESPIRATORY SYSTEM					
Sinusitis	2.6	2.8	0.0	2.5	6.4
Pharyngitis	1.5	2.5	0.0	1.3	2.1
SKIN AND APPENDAGES					
Rash	0.7	3.9	2.8	3.8	1.1
MUSCULOSKELETAL SYSTEM					
Arthralgia	1.5	2.0	0.0	5.1	0.0
Myalgia	1.1	3.2	5.6	1.3	0.0

The following adverse events were reported, regardless of causality assessment in patients treated with atorvastatin in clinical trials. The events in *italics* occurred in >2% of patients and the events in plain type occurred in <2% of patients.

Body as a Whole: Chest pain, face edema, fever, neck rigidity, malaise, photosensitivity reaction, generalized edema. **Digestive System:** Nausea, gastroenteritis, liver function tests abnormal, colitis, vomiting, gastritis, dry mouth, rectal hemorrhage, esophagitis, eructation, glossitis, mouth ulceration, anorexia, increased appetite, stomatitis, biliary pain, cheilitis, duodenal ulcer, dysphagia, enteritis, enteric, melena, gum hemorrhage, stomach ulcer, tenesmus, ulcerative stomatitis, hepatitis, pancreatitis, cholestatic jaundice. **Respiratory System:** Bronchitis, rhinitis, pneumonia, dyspnea, asthma, epistaxis. **Nervous System:** Insomnia, dizziness, paresthesia, somnolence, amnesia, abnormal dreams, libido decreased, emotional lability, incoordination, peripheral neuropathy, torticollis, facial paralysis, hyperkinesia, depression, hyposthesia, hypertension. **Musculoskeletal System:** Arthritis, leg cramps, bursitis, tenosynovitis, myasthenia, tendinous contracture, myositis. **Skin and Appendages:** Pruritus, contact dermatitis, alopecia, dry skin, sweating, acne, urticaria, eczema, seborrhea, skin ulcer. **Urogenital System:** Urinary tract infection, urinary frequency, cystitis, hematuria, impotence, dysuria, kidney calculus, nocturia, epididymitis, fibrocystic breast, vaginal hemorrhage, albuminuria, breast enlargement, metrorrhagia, nephritis, urinary incontinence, urinary retention, urinary urgency, abnormal ejaculation, uterine hemorrhage. **Special Senses:** Amblyopia, tinnitus, dry eyes, refraction disorder, eye hemorrhage, deafness, glaucoma, periorbital, taste loss, taste perversion. **Cardiovascular System:** Palpitation, vasodilatation, syncope, migraine, postural hypotension, phlebitis, arrhythmia, angina pectoris, hypertension. **Metabolic and Nutritional Disorders:** Peripheral edema, hyperglycemia, creatine phosphokinase increased, gout, weight gain, hypoglycemia. **Hemic and Lymphatic System:** Echinomycosis, anemia, lymphadenopathy, thrombocytopenia, petechia. **Postintroduction Reports** — Adverse events associated with LIPITOR therapy reported since market introduction, that are not listed above, regardless of causality assessment, include the following: anaphylaxis, angioneurotic edema, bullous rash (including erythema multiforme, Stevens-Johnson syndrome, and toxic epidermal necrolysis), and rhabdomyolysis. **Pediatric Patients (ages 10-17 years)** In a 26-week controlled study in boys and postmenarcheal girls (N=140), the safety and tolerability profile of LIPITOR 10 to 20 mg daily was generally similar to that of placebo (see CLINICAL PHARMACOLOGY, Clinical Studies section in full prescribing information and PRECAUTIONS, Pediatric Use).

OVERDOSAGE: There is no specific treatment for atorvastatin overdose. In the event of an overdose, the patient should be treated symptomatically, and supportive measures instituted as required. Due to extensive drug binding to plasma proteins, hemodialysis is not expected to significantly enhance atorvastatin clearance.

Please see full prescribing information for additional information about LIPITOR.

R only

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MEDICAL TECH

BRAIN PACEMAKER

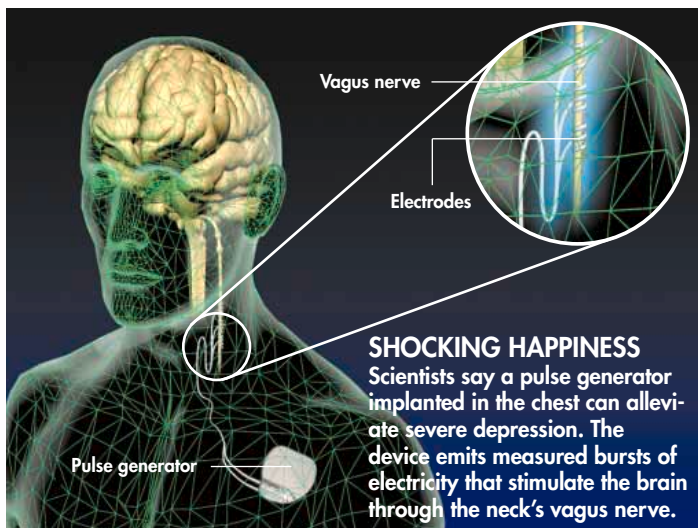
Implantable electroshock therapy eases depression.

▶ For two decades, Jill spent one month a year in the hospital trying not to kill herself. Her severe depression was immune to medication and even electroshock therapy. But a silver dollar-size pulse generator implanted in her chest three years ago seems to have helped. Electrodes from the device wind around the vagus nerve in Jill's neck and zap it with two milliamps of current for 30 seconds every five minutes. Unlike traditional electroshock therapy, this approach, called vagus nerve stimulation, or VNS, is targeted at just one part of the brain and uses a very low voltage. The VNS implant, made by Cyberonics in Houston, is already approved for the treatment of epilepsy and could receive FDA clearance for depression this summer.

Neurologists are still struggling to understand what causes depression, says Jill's doctor and VNS researcher Mark George of the Medical

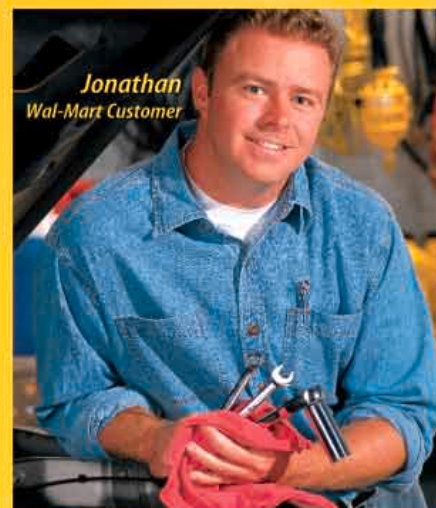
University of South Carolina. The new therapy is revealing fresh insights. Like a thick coaxial cable, the vagus nerve carries signals from the heart, lungs and stomach to the mood centers of the brain. Although the connection between our organs and emotions is poorly understood, George speculates that depressed patients have weakly regulated signals coming from their hearts and guts. The VNS electrodes "reregulate those signals," he explains, and at least in the 30 percent of patients like Jill who respond to treatment, the depression goes away.

What about side effects? While patients can't feel the implant, some say that their voice changes or that they get short of breath when the electrodes are firing. Most agree, however, that VNS therapy is far more tolerable than the insomnia, weight gain and sexual dysfunction associated with common depression medications.—WILLIAM SPEED WEED



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PERSPECTIVE

SEA SICKNESS, BY THE NUMBERS

A new report on marine health could make you queasy.

- 30** Number of years since the last comprehensive government review of national marine health and ocean policy.
- 4.5 MILLION** Square miles of ocean territory under U.S. jurisdiction—larger than the combined land area of all 50 states.
- 50** Estimated percentage of the U.S. population living within 50 miles of the coastline.
- 40,000** Estimated number of U.S. sewers that overflow annually, discharging waste directly into rivers, estuaries and oceans.
- 12,000** Number of beach closings and swimming advisories in 2002 due to bacterial contamination from fecal matter.
- 2,429** Number of those closings and advisories that were in Guam.
- 4 BILLION** Number of pounds of seafood consumed in the U.S. annually.
- 62** Percentage of seafood-related illnesses due to marine toxins.
- \$117 BILLION** Dollars that fishing and other marine industries contribute to the U.S. economy annually.

SOURCES: 2004 U.S. Commission on Ocean Policy Preliminary Report, Natural Resources Defense Council



WASTE



RECYCLING



WELL-FED ASTRONAUTS

ENGINEERING

CREATIVE WASTE MANAGEMENT IN SPACE

For Mars-bound astronauts, fuel may be just one flush away.

► Shih-Ger Chang, a senior scientist at the Lawrence Berkeley National Laboratory, has developed a recipe to feed astronauts on a three-year round-trip mission to Mars. His secret ingredient? Human waste. Before you turn the page in disgust, consider Chang's rationale. "It sounds dirty, but in deep space you can't afford to throw things away," he says. "When you burn feces, molecules break down and you get a fertilizer for growing wheat and sweet potatoes." More specifically, he has discovered that wheatgrass heated to 600°C forms an activated carbon that can convert nitrogen oxide emissions from burned feces into nitrogen and ammonia. Voilà: fertilizer! Meanwhile the activated carbon can be used for water-filtration and air-recycling equipment. "It's a fully regenerative life-sustaining system," Chang says.

As of now, the setup is rather long and complicated, involving multiple steps of packing, purging and heating the ingredients. Ultimately, Chang wants to automate the entire process. "Ideally, an astronaut would only need to push a button and all the steps would function sequentially and automatically," he says. Sort of like flushing a toilet. —MICHAEL ROSENWALD

THE POPSCI OPINION POLL
BASED ON 2,696 RESPONSES POSTED
TO POPSCI.COM FROM 5/7 TO 6/4

LAST MONTH
WE ASKED:

A REVAMPED
SPACE
SHUTTLE IS
SLATED TO
LAUNCH
NEXT MARCH.
DO YOU
HAVE FAITH IN
THE MISSION?

[NO]

15%

[YES]

85%



THIS MONTH'S
OPINION POLL:
GENE THERAPY
COULD HELP
INJURIES HEAL
FASTER.
SHOULD WE
BAN IT FROM
ATHLETICS?

WHAT DO YOU THINK?
POPSCI.COM

FROM LEFT: COURTESY AMERICAN STANDARD; PHOTONICA; NASA (2)

POLLUTION WATCH

AIR TRAFFIC BLUES

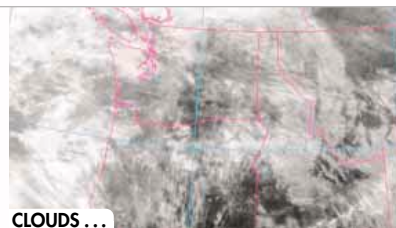
NASA links jet contrails to global warming. Now what?

▶ In 2002, using data collected during the three-day grounding of all aircraft in the U.S. after 9/11, scientists discovered that contrails—the wispy white streaks that trail jets—were narrowing the natural day-night temperature cycle in well-trafficked areas. Now a NASA study indicates that warmed-up nights are outpacing cooled-down days. In the U.S., for example, detailed atmospheric modeling suggests that contrails could account for a climate-warming trend—just under 0.3°C per decade—measured between 1975 and 1994. That amount may seem trivial, but as air traffic grows (major airlines are expected to increase their fleets 40 percent by 2015), the rate of

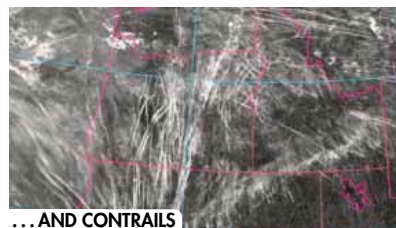
temperature increase may be six times as great by 2050.

Contrails form as the water vapor in jet exhaust condenses and freezes whenever an airplane flies between roughly 28,000 and 40,000 feet. In the presence of enough humidity, they spread into huge, thin cirrus clouds: A few contrails can merge into a swath the size of Kansas and Nebraska. The clouds trap infrared energy radiated by Earth, causing a temperature spike similar to the greenhouse gas effect.

Unfortunately, the only ways to clear the air would be to fly below the contrail zone (burning more fuel and bucking more turbulence), fly above it (where emissions would be more likely



CLOUDS ...



... AND CONTRAILS

A STANDARD INFRARED SATELLITE IMAGE SHOWS CLOUD COVERAGE (TOP). A DOUBLE-WAVELENGTH INFRARED IMAGE REVEALS THE UNDERLYING CONTRAILS (BELOW).

to damage the ozone layer), or invent a radical new method of propulsion that does not produce water vapor. Patrick Minnis, the senior researcher of the NASA study, admits that the outlook is gloomy. "It's not like you're never going to have a blue-sky day," he says, "but you're certainly going to have fewer and fewer." — JOSHUA TOMPKINS



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IDEAS & INVENTIONS

ANTI-TERROR PATENTS PILE UP

Scores of independent inventors rally to secure the homeland, one bizarre gadget at a time.

▶ Since September 11, 2001, the U.S. Patent and Trademark Office has received at least 300 applications for devices designed to win the war on terrorism. “Historically, when there is a cataclysmic event, there is a surge in inventor response,” says Richard Maulsby, public affairs officer at the agency. Among the newly minted patents is Boeing’s “intruder-proof flight deck door,” which secures an airplane’s cockpit from the cabin.

But behemoth companies aren’t the only ones procuring patents to guard the homeland. “Plenty of independent inventors redirected their energies to anti-terrorism inventions after 9/11,” says Andy Gibbs, CEO of Patent-Cafe, a developer of intellectual-property-management software. “Many now have patents to show for that.” Refrigeration technician cum inventor John R. Cunningham of Marathon, Florida, is now the proud holder of patent #6,646,270 for a germicidal mailbox that uses ultraviolet light to decontaminate rogue bills and junk mail. Creative, sure, but will it woo commercial interest? Probably not. (Cunningham notes that anthrax threats have tapered off, and so has interest in his mailbox.) “Just because you have an anti-terrorism patent doesn’t mean you have an anti-terrorism product—not by a long shot,” Gibbs says. Which would-be Edisons, if any, will make it big? Below, we evaluate a few contenders and their freshly patented anti-terror gadgets.—JILL DAVIS

	THE PATENT	THE INVENTORS	WHAT IT IS	HOW IT WORKS	COMMERCIAL ODDS
	Flying Airbag Jumpsuit	Jack Chen Taipei, Taiwan Patent #6,708,927	Apparatus for slowly and safely descending from a high-rise building. Think flying Michelin Man.	Zip into suit, inflate first set of airbags. Upon jumping, inflate secondary airbags; parachute releases.	10,000 to 1: invention leaves little room for errors; requires unrealistically complex training courses.
	Germicidal Mailbox	John R. Cunningham Marathon, Florida Patent #6,646,270	Standard mailbox outfitted with an ultraviolet light that radiates at a wavelength of 254 nanometers.	Mail rotates inside an internal cage while 15-minute UV light cycle zaps spores and germs.	25 to 1: the risk of falling ill from germy mail is slim; many post offices already irradiate mail.
	Suspicious-Object Container	Jerome Landy Coral Gables, Florida; Keith Landy, Ormond Beach, Florida Patent #6,595,247	Portable cylindrical chamber with handling gloves and a port for a gas chromatograph.	Device creates airtight seal over object and enables on-site examination and decontamination.	2 to 1: big improvement over the typical portable containment system—garbage bags and duct tape.
	In-Flight Emergency Alert System	Joseph Cordina Parker, Texas; Anthony Couzelis Plano, Texas Patent #6,676,078	Wireless system of hidden, wearable radio transmitters, an antenna in the cabin and a cockpit monitor.	Attendants use wearable fobs to send coded emergency signals to cockpit and/or ground control.	5 to 1: federal legislation requiring airlines to use wireless communication-alert devices is pending.

PREDICTION



HEADLINE FROM THE FUTURE BY THEODORE FRIEDMANN

2024 OLYMPIC GAMES, SAN DIEGO, RECORDS SMASHED!

Thanks to advances in genetic engineering, this year’s crop of Olympic contenders is faster, healthier and *older* than ever. Cheating athletes now turn to powerful gene therapies designed to treat illnesses such as cancer. Sprinters beef up by injecting genes that stimulate muscle growth, marathoners extend their endurance with genes that boost red blood cells, and aging athletes compete longer due to fewer injuries. The result: Records are smashed. The gains are illicitly gotten, but tests that distinguish injected genes from natural ones don’t turn up all the cheaters—some find new ways to slip by undetected.

Dr. Theodore Friedmann is director of the human gene therapy program at the University of California at San Diego.

FUNDED CASSINI-HUYGENS SPACECRAFT IS SLATED TO ARRIVE AT SATURN’S RINGS AND BEGIN A FOUR-YEAR ORBITAL STUDY OF THE PLANET AND ITS MYSTERIOUS MOON, TITAN. ■



AP WORLDWIDE

MEET THE BOYS FROM R&D

U.S. Special Forces, Navy SEALs, and the FBI are just a few of the professionals who depend on our flashlights and weapon-mounted lights. But they're not just our customers, they're also our research and development team. Based on their combat experience — and our breakthrough engineering — we've evolved a class of lights that are smaller, tougher and brighter than anything you know as a flashlight. So how do you make a light that measures up to the men who use it? You start with up to 33 times more power than a standard two D-cell flashlight, add a shock-isolated lamp built to withstand the recoil of a 12-gauge shotgun, use 10-year shelf life lithium batteries, and then wrap it all up in aerospace-grade aluminum with an ultra-rugged MilSpec finish. Whether you need to clear a bunker or simply find your way in the dark, you'll never regret having the best tool for the job. SureFire. No other light compares.

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MILITARY TECH VERSUS STREET TECH:



THE VITALS: **H2 SUT**

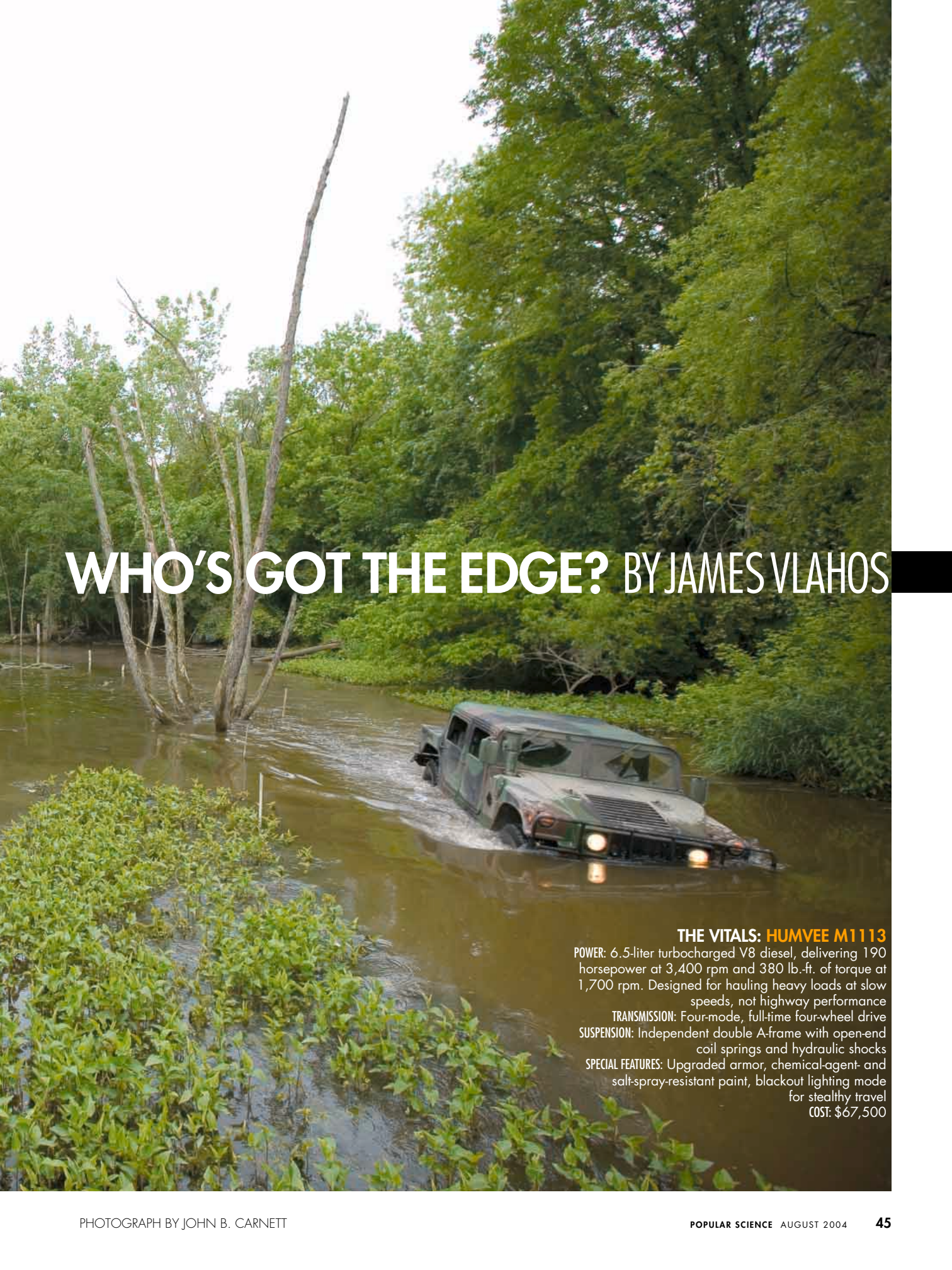
POWER: 6.0-liter Vortec 6000 V8, which delivers 325 horsepower at 5,200 rpm and 365 lb.-ft. of torque at 4,000 rpm

TRANSMISSION: Seven-mode, full-time four-wheel drive

SUSPENSION: Variable-rate, independent, linked system

SPECIAL FEATURES: Bosch four-channel antilock brakes, heated front and rear seats

COST: \$52,845



WHO'S GOT THE EDGE? BY JAMES VLAHOS

THE VITALS: **HUMVEE M1113**

POWER: 6.5-liter turbocharged V8 diesel, delivering 190 horsepower at 3,400 rpm and 380 lb.-ft. of torque at 1,700 rpm. Designed for hauling heavy loads at slow speeds, not highway performance

TRANSMISSION: Four-mode, full-time four-wheel drive

SUSPENSION: Independent double A-frame with open-end coil springs and hydraulic shocks

SPECIAL FEATURES: Upgraded armor, chemical-agent- and salt-spray-resistant paint, blackout lighting mode for stealthy travel
COST: \$67,500



RADAR. THE INTERNET. THE JEEP. THE GLOBAL Positioning System. Technologies developed for the military often cross over to the civilian world—subtly or still in character. A Hummer, even painted lemon yellow and parked downtown, still looks battle-ready. And technology crosses back too. The Marines' Dragon Runner surveillance vehicle was inspired by the radio-controlled car industry; the controller was copped from a PlayStation 2.

The question naturally occurs: Who gets the better stuff, soldiers or civilians? The military's gear is often tougher (witness their laptops and cars), more precise and sometimes just plain better, because extreme situations require extreme gear. Civilians, meanwhile, have the advantage of speed. It can take the military eight years to field a new pair of socks. Before making a purchase, consumers think simply, Do I like it? Military procurement officers must ask, "Can we entrust soldiers' lives to it?" Consumers—capricious, gadget-hungry, hundreds of millions strong—frequently drive market innovations. The military has traditionally tried to develop, own, and control its own technology.

But the thinking is shifting, and procurement officers now get pats on the back when they fulfill a military need with a consumer product. The new approach has forged strange alliances, such as the Army's partnership with the video game industry to create a soldier trainer called *Full Spectrum Warrior* (see page 52). "Crossing over" is too simple a term for what's happening; perhaps a Möbius strip better captures the complex relationship between military and civilian tech.

The evaluations on these pages are subjective, debatable and, in many ways, totally unfair. We stand by them completely. In our judging, we considered technological sophistication—a missile-controlling helmet beats one with only a data screen—and effectiveness: How well does the device do what it is intended to do?

It would be shortsighted, of course, to discuss what's happening with military tech without discussing what's happening with the military. We are at war, and every new technology is being developed with an eye toward what is going right—and what is going terribly wrong—in Iraq and Afghanistan. New conflicts—smaller, urban, unconventional—will require new tools and tactics. "Soldier-centric warfare" and "situational awareness" are the buzz phrases, because tanks and bombs have limits when you're fighting among civilians. This combat paradigm places an increased emphasis on the very sort of high-tech tools civilians use. You depend on your PDA to remind you of a lunch meeting. Soldiers, linked by wireless networks, may soon be using theirs to make the right decisions about when to shoot—and when to hold fire.



TERRAIN NEGOTIATION

HUMVEE VS. H2 SUT

The military version is tougher and buries its urbane cousin off-road, but which one would you really want to spend time in?

► As a street-legal SUV, the Hummer H1—the consumer version of the military's famous Humvee—is overbuilt in the extreme, like Fort Knox or the Giza pyramids or the Broadway production of *The Lion King*. You probably won't need to paradrop from a helicopter or drive through a waist-deep stream on the way to dinner at Le Grand Fromage, but it sure is nice to know that you *could*. AM General, which builds both the military and civilian versions, recently realized, however, that the H1 is too much truck for many buyers. In 2002 the company introduced the toned-down H2 and, this summer, the H2 Sport Utility Truck (SUT), which has a fold-down midgate that allows it to convert into a pickup with a 4-by-6-foot bed. The design challenge was to meet a standard of both Hummer burliness (steel structure and a V8 engine) and upmarket friendliness (eight-way adjustable leather seats, XM satellite radio, keyed ignition and, well, doors). Buyers want military realism, though not military reality, it would seem. The Humvee is undoubtedly the beefier vehicle. It can clear higher rocks (16 inches versus 10) and drive through deeper water (60 inches versus 20). But when it comes to combining off-road performance with on-road driving comfort, the H2 is king of the hill.

JOHN B. CARNETT

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TACTICAL COMMUNICATION

D-DACT VS. HP IPAQ 5555

Consumer demand may drive PDA tech, but G.I.'s jumped to the head of the class with their rugged, waterproof, networked units. Will they stay out front?

► Your PDA tells you many things—the time of a meeting, the phone number of a colleague. It entertains with games and MP3s. But it does not tell you to step right to avoid a landmine. It does not tell you to pull the trigger. Not unless you are a Marine, that is, and the device is the D-DACT, a PDA the military hopes will do nothing less than take war into the wireless age. Instead of drifting dangerously out of touch, soldiers will be networked through D-DACT modems, which communicate over military radio frequencies. They can share enemy positions and other tactical data, creating a common picture of the combat zone. At its core, the D-DACT is a 5500-series HP iPAQ, with 128 megabytes of RAM, a 400MHz processor and a 64,000-color screen. The consumer iPAQ looks like your typical chrome-colored handheld, but the military version wears fatigues—an olive-drab, ruggedized, waterproof case. An external battery pack gives the D-DACT up to 16 hours of continuous operation versus the iPAQ's 3. D-DACT has a built-in GPS system that, unlike consumer versions, resists signal jamming. "The D-DACT is a super-PDA," system engineer Frank Stepanski says. The question is, will it remain that for long? The first field deployments are expected to take place in January and proceed through 2005 and 2006. Consumer technology keeps evolving, but the Marines won't issue replacements until at least 2007.



THE VITALS: D-DACT

WEIGHT: 31 ounces
WIRELESS: VHF-spectrum modem
STANDARD APPLICATIONS: Command and Control CE, map software
EXTRAS: Anti-spoofing GPS module
COST: \$10,000

THE VITALS: IPAQ 5555

WEIGHT: 7.3 ounces
WIRELESS: Bluetooth, WLAN 802.11b
STANDARD APPLICATIONS: Microsoft Pocket Office, MSN Messenger
EXTRAS: Biometric fingerprint reader for security
COST: \$650

ENVIRONMENTAL PROTECTION

OUTDOOR GEAR

The military's integrated system finally catches up to—and in some cases surpasses—civilian all-weather apparel and equipment.

BOOT CAMP

For soldiers, sturdiness is key. The Protective Combat Uniform includes a compressible fleece jacket made of no-rip, velour-backed Polartech Thermal Pro (1), four times as warm as cotton. Moderately water-resistant and stretchy, maximally breathable "softshell" jackets and pants have made it to the military PCU (2). The PEPSE system uses the traditional leather and steel LaSportiva Lhotse boots (3). The Thales MBITR radio (4) transmits up to five miles. The Gerber 600 DET (5), in nonreflective black, has tools a non-MacGyver civilian would never use—an explosives punch, a blasting cap crimper. The screw-top fill system, antimicrobial tube treatments and lever-lock valves of the Camelbak Ambush hydration pack (6) were initially developed for the military. The Mystery Ranch Big Ds Special Blend (7), a 7,400-cubic-inch backpack, carries plenty of gear. Oakley M sunglasses (8) are popular in the military because they have broad, strong lenses, which protect against shrapnel and don't interfere with aiming. The gloves? Consumer off-the-shelf from Outdoor Research (9). The Multi-Climate Protection System base layer (10) traps heat and wicks moisture.



► At left, the gear and garb of a Special Operations Forces soldier outfitted for serious cold. At right, a similar consumer ensemble. The difference—well, fortunately, it ain't what it used to be. "Cotton kills" has been a truism of the outdoor world for decades, but the military is now switching to synthetic base layers. The new gear—most of it belonging to the Personal Environmental Protective Survival Equipment (PEPSE) system—consists of ruggedized consumer tech. The clothing contains elements of the new Protective Combat Uniform (PCU), developed by the U.S. Army Soldier Systems Center with input from companies such as Patagonia, La Sportiva and Malden Mills. A soup-to-nuts system, the PCU's seven levels can be mixed to handle temperatures from 65°F to -40°F. Specially positioned stretch panels facilitate combat movements (firing weapons, for instance), the fabric color spoofs night-vision sensors, and varied seam positions prevent painful stacking under backpack straps.



STYLING BY ELIZABETH ENGELHARDT



BASE CAMP

The Patagonia Flash Pullover has lofted pillars for insulation (11). The Arc'Teryx Alpha SV Jacket (12) features XCR, the best form of Gore-Tex, but it's too noisy and not breathable enough for soldiers. Marmot ATV pants (13) feature 3XDRY, a fast-drying, stretchable nylon. Lowa Biomex Vertex (14) uses a flexing plastic cuff to combine big-boot stability and sneaker comfort. Motorola Talkabout T5950 (15) has a five-mile range. The new titanium Leatherman Charge Ti (16) includes two sets of pliers, wire cutters, a saw, scissors and files. Civilian hydration packs, including the Lobo (17), have adopted military innovations, but few are constructed from virtually indestructible 1,000-denier nylon. The 3,700-cubic-inch Osprey Switch 55+5 backpack (18) exemplifies the less-is-more trend among skiers and hikers. For consumer sunglass buyers, style counts; the strength and svelteness of the Oakley Magnesium Switch (19) is a bonus. With tough Cordura shells and Gore-Tex/pile liners, Outdoor Research's Modular Glove System (20) is good for skiers and soldiers alike. Patagonia R.5 Superfly Tights and Top base layer (21) insulates as well as the soldier gear does.



SITUATIONAL AWARENESS

JOINT HELMET-MOUNTED CUEING SYSTEM VS. SPORTVUE

Way bigger budget, way bigger needs—controlling weapons and sensors while flying a fighter plane in combat—result in way better head-up display.

► **Goose died.** Goose died because *Maverick* couldn't get the enemy plane into the 20-degree field-of-view of his head-up display (HUD) and thus couldn't establish a radar lock to fire his missiles. True, the *Stratocasters* scream less sonorously in real-life fighter cockpits, but when it comes to dogfights, *Top Gun* gets it right: Position is everything. That's why U.S. Air Force and Navy pilots using the new Joint Helmet-Mounted Cueing System (JHMCS) have such an advantage. The system projects key data—air speed, altitude, orientation, the location of enemy fighters and more—onto the inside of the helmet visor. Unlike current HUDs, which are small screens fixed in place above the instrument panel, the JHMCS moves; the pilot's head motions, magnetically tracked, can be set to steer weapons and sensors. The targeting cone blossoms to 360 degrees, so pilots are able to fire at whatever they can see. This year,

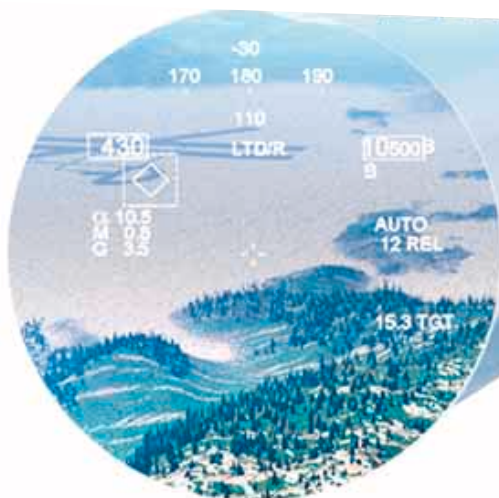


THE VITALS: **SPORTVUE**

DISPLAY TYPE: Backlit liquid crystal

DATA DISPLAYED: Gear, speed, rpms. Racing versions, available for bicycles as well, include lap time, performance data and other user-programmable functions

COST: \$270 and up



for the first time, recreational motorcyclists and bicyclists can get a taste of the same technology with the SportVue helmet, developed by MotionResearch. The altitude is lower, but the idea is the same: Display vital data in front of the operator's eyes—focused well in front of the rider—eliminating the potentially dangerous distraction of looking down. Mounted to any off-the-shelf helmet visor, SportVue's miniature LCD screen displays speed, gear and engine rpms—and other user-programmable functions in the race versions—receiving data wirelessly from sensors mounted on the bike.



THE VITALS: **JHMCS**

DISPLAY TYPE: Miniaturized CRT monitor, which is reflected in green on the pilot's visor

DATA DISPLAYED: Includes air speed, altitude, target range, weapon selected, maximum G-force pulled, radar view, incoming missile alerts, infrared view

COST: Classified

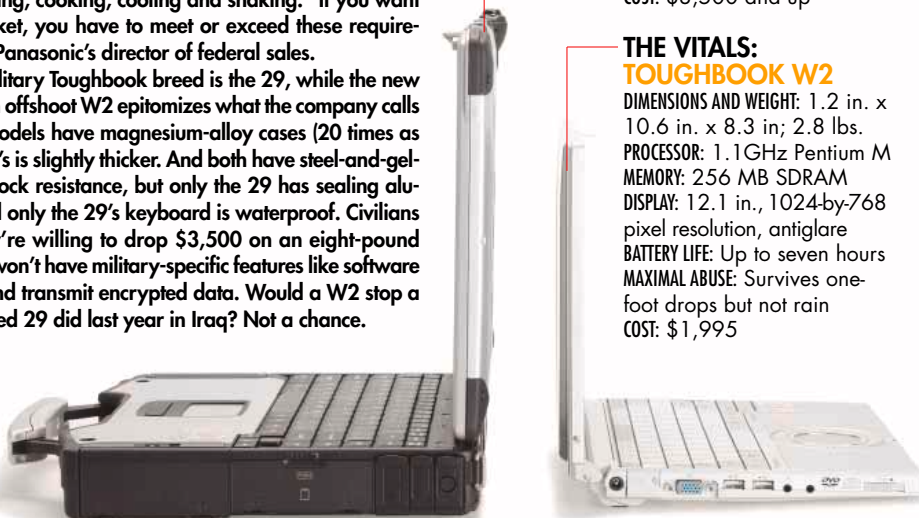
STRATEGIC ANALYSIS

PANASONIC TOUGHBOOK 29 VS. TOUGHBOOK W2

Replacing computers in Iraq isn't easy—so the military opts for the thicker, better-sealed, waterproof machine.

► When Panasonic Toughbooks go to war—the company is the leading supplier of ruggedized military laptops, with more than 10,000 computers deployed in Iraq—they must withstand being sprayed by saltwater, shaken by mortar fire, and run over by Humvees. Certification involves an intense gauntlet of dropping, dousing, cooking, cooling and shaking. “If you want to play in the rugged market, you have to meet or exceed these requirements,” says Jan O’Hara, Panasonic’s director of federal sales.

The bullmastiff of the military Toughbook breed is the 29, while the new ultrathin, 2.8-pound civilian offshoot W2 epitomizes what the company calls “business rugged.” Both models have magnesium-alloy cases (20 times as strong as plastic) but the 29’s is slightly thicker. And both have steel-and-gel-encased hard drives for shock resistance, but only the 29 has sealing aluminum port protectors, and only the 29’s keyboard is waterproof. Civilians can purchase 29s—if they’re willing to drop \$3,500 on an eight-pound machine, that is—but they won’t have military-specific features like software to track enemy positions and transmit encrypted data. Would a W2 stop a bullet, like a fully ruggedized 29 did last year in Iraq? Not a chance.



THE VITALS: TOUGHBOOK 29

DIMENSIONS AND WEIGHT: 2.3 in. x 11.8 in. x 9.5 in.; 7.94 lbs.
PROCESSOR: 1.3GHz Pentium M
MEMORY: 512MB SDRAM
DISPLAY: 13.3 in., 1024-by-768 pixel resolution, antireflective
BATTERY LIFE: Up to four hours
MAXIMAL ABUSE: Survives rainstorms and three-foot drops
COST: \$3,500 and up

THE VITALS: TOUGHBOOK W2

DIMENSIONS AND WEIGHT: 1.2 in. x 10.6 in. x 8.3 in.; 2.8 lbs.
PROCESSOR: 1.1GHz Pentium M
MEMORY: 256 MB SDRAM
DISPLAY: 12.1 in., 1024-by-768 pixel resolution, antiglare
BATTERY LIFE: Up to seven hours
MAXIMAL ABUSE: Survives one-foot drops but not rain
COST: \$1,995

MOBILE NAVIGATION

DRAGON FIRE VS. LEXUS NAVIGATION

Precision is paramount when aiming missiles—more so than when driving to the mall—and \$150,000 per system scores the primo parts.

► When a computer-aided weapon is firing from a moving vehicle, it pretty much has to know exactly where it is at all times. Dragon Fire, a new mortar-firing system being developed by the Marine Corps Warfighting Lab, employs a GPS unit enhanced by a ring-laser gyroscope. The result is a weapon capable of unprecedented firepower—remotely initiated, controlled by a skeleton crew, and with pinpoint accuracy.

Accuracy also matters off the battlefield. In Lexus’s 2004 luxury sedans, for example, the state-of-the-art navigation system has a dual-layer DVD map database, is programmed with five million points of interest, and responds to 200 voice commands (“Which way to Taco Bell?”). The device is accurate to within 10 feet. Should the GPS lose satellite contact in deep woods or a long tunnel, it dead reckons, calculating from the last known location with a magnetic compass and wheel and steering sensors. Impressive stuff, but Dragon Fire is still more accurate. Its ring-laser gyro—which tracks movement by measuring the difference in frequency of two laser beams—can accurately figure position to within three feet. So why don’t consumer GPS devices have ring lasers? One argument—beyond their current high cost—is that they’re needlessly accurate. Consumer maps are fraught with minor errors; automotive systems compensate by displaying not where they think you actually are but where you should be—on the highway, not doing 75 through the adjacent Wal-Mart parking lot.

THE VITALS: DRAGON FIRE NAVIGATION

MAXIMUM ERROR: 3 feet; 30 feet when signal is lost.
HARDWARE: GPS, ring-laser gyro



THE VITALS: LEXUS NAVIGATION

MAXIMUM ERROR: 10 feet; 40 feet when signal is lost
HARDWARE: GPS, speed sensor, wheel angle sensor

TRAINING AND SIMULATION

FULL SPECTRUM WARRIOR

Consumer videogame technology inspires the U.S. Army's new recruit-friendly training tool. Then it bounces back to the consumer market and to an Xbox near you.

► *Full Spectrum Warrior*, a new videogame for the Xbox, feels real. The setting is the fictional locale of Zafarra, Zekistan, but it may as well be Baghdad, Iraq. You command two four-soldier infantry squads and are charged with securing neighborhoods and rescuing wounded comrades. Your men dash across dusty streets, slink along chipped walls, and launch grenades from behind overturned cars. Bullets fly. Bodies fall like rag dolls.

The game feels realistic because it is. Developed as a training tool for the U.S. Army and modified for commercial release this summer, *FSW* rewards players who follow by-the-book tactics for flanking, taking cover, laying down suppression fire, and more. "We spend a lot of time and money training colonels and generals, but we've never had anything good like this for squad leaders," says Michael Macedonia, the Army's chief technology officer for training and simulation. The commercial version of the game promises to be a hit as well—*FSW* won the Critic's Choice award at E3, the videogame industry's key trade show, and most critics count it among the year's very best games.

Through a partnership that perfectly illustrates the modern entwining of military and consumer technology, in 1999 the Army established the Institute for Creative Technologies (ICT) at the University of Southern California. A research lab of computer scientists, television producers, videogame designers and filmmakers, the ICT's charter was to find engaging new ways to instruct young soldiers. In 2000 the lab enlisted Pandemic Studios, a private videogame developer, to create what would become *FSW*.

Project leader Wil Stahl met with generals, captains and sergeants. They knew that a videogame could never teach a soldier to shoot, but they hoped that one could offer tactical instruction and simulate, however faintly, the stress of making decisions under fire. For Pandemic it was a chance, backed by \$45 million of the military's money, to develop a novel game that combined God's-eye strategy with first-person-shooter action, two approaches that the videogame industry typically considers mutually exclusive.

Pandemic went on to create a trainer with graphics and action that were as good as those for any game on the consumer market, along with artificial intelligence for nonplayer characters and tactical accuracy that were even better. The military version of *FSW* was tested last year by soldiers at Fort Benning, Georgia. The consumer version was released in late spring. They look virtually identical but don't play the same; the differences are what distinguish war trainer from war toy. In the home version, guide your squads correctly and you'll always be rewarded. In the Army game, even good moves are occasionally punished. The lesson is that cruel, capricious fate is an inherent part of war.

The intersection of gaming and reality is what's most interesting about *FSW*. Stahl says that during development, Army commanders "became very interested in how you could issue commands with a finite interface." They were envisioning not only the future game but a future war, with "soldiers wearing display monacles and head-mounted cameras," Stahl says. "Their squad leader, safe in a tank, sees what they see, and directs their actions with an Xbox-like controller." Pandemic and ICT, it seems, had helped to advance not only videogames that imitate war, but the idea that war might someday imitate videogames. ■

THE VITALS: FULL SPECTRUM WARRIOR

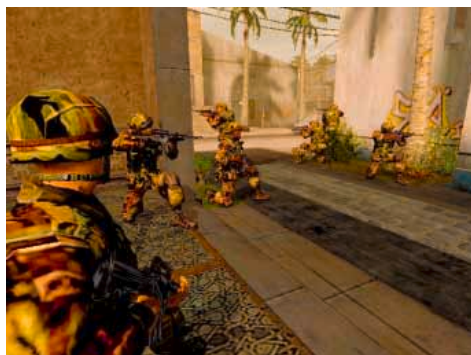
PLATFORM: Xbox

SCENARIO: Command of two squads in dense urban environment

TACTICAL TRAINING: Crossing open terrain, using corners as cover, securing an enemy, stack formation, chain of command

COST: \$50

EXTRAS: Live online gameplay



SIMULATOR As a squad leader in *FSW*, players guide soldiers through a variety of tense urban combat situations.





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Is Science Fiction About to Go Blind?

Awed at the pace of technological advances, a faction of geeky writers believes our world is about to change so radically that envisioning what comes next is nearly impossible.

By Gregory Mone • Photograph by Fredrik Brodén

THE STARSHIP *FIELD CIRCUS* IS RACING THROUGH SPACE on a seven-year journey to a brown dwarf three light-years from Earth and, if all goes well, a business meeting with an alien civilization from another universe. It's around the year 2030, and there's time to kill, so three crew members, Boris, Pierre and Su Ang, are sitting in the bar, a wood-paneled room modeled after a 300-year-old pub in Amsterdam. There's a 16-page beer menu, but Boris has opted for a cocktail made of baby jellyfish. Pierre is angling for a sip when Donna the Journalist appears. She isn't exactly welcome, but she sits down anyway, orders a bottle of German beer from the waiter, and asks the three if they believe in the Singularity.

Ah yes, the Singularity. A very real term, although the scene above is taken from a soon-to-be-published novel, *Accelerando*, by British writer Charles Stross. The idea was conceived by Vernor Vinge, a computer scientist and science-fiction writer who's now a professor emeritus at San Diego State University. We're living through a period of unprecedented technological and scientific advances, Vinge says, and sometime soon the convergence of fields such as artificial intelligence and biotechnology will push humanity past a tipping point, ushering in a period of wrenching change. After that moment—the Singularity—the world will be as different from today's world as this one is from the Stone Age.

Back on board the *Field Circus*, Donna the Journalist asks the crew members when they think the Singularity took place. "Four years ago," Pierre suggests. Su Ang votes for 2016. But Boris, the jellyfish drinker, says the entire notion of a Singularity is silly. To him, there's no such thing. Wait a minute, Su Ang responds. Here we are, traveling in a spaceship the size of a soda can. We've left our bodies behind to conserve space and energy so that the laser-sail-powered *Field Circus* can cruise faster. Our brains have been uploaded and are now running electronically within the tiny spaceship's nanocomputers. The pub is "here," along with other virtual environments, so that we don't go into shock from sensory deprivation. "And you can tell me that the idea of a fundamental change in the human condition is nonsense?"

Accelerando is the story of three generations of a dysfunctional family living through the Singularity. What makes the novel unusual is not the size of the ship or the strange cocktails or even the sexual metaphors—a coital act culminates with the transfer of "source code"—but the fact that Stross is

attempting to imagine the relatively near-term future. This is a strangely courageous act, because modern science fiction is facing a crisis of confidence. The recent crop of stories mostly take the form of fantasy (elves and wizards), alternate history (what if the Black Death had been deadlier?) and space operas about interstellar civilizations in the year 12,000 (which typically gloss over how those civilizations evolved from ours). Only a small cadre of technoprophets is attempting to extrapolate current trends and imagine what our world might look like in the next few decades. "We're staring into a fogbank," Stross says, "and we literally do not know where we're going, only that we're going there very fast."

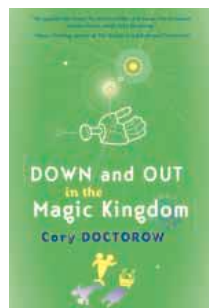
THE SCIENCE-FICTION LEGENDS—Arthur C. Clarke, Isaac Asimov, Robert Heinlein—still loom imperiously. Clarke pulled humanity's technological reach to the heavens, with visions of communications satellites, space elevators and rotating space stations. Asimov changed our perspective here on Earth, filling our homes with robots that dust, cook—and



SINGULAR VISIONS
WRITERS CHARLES STROSS (ABOVE) AND CORY DOCTOROW (BELOW) SPECULATE ON WHETHER ARTIFICIAL INTELLIGENCE WILL SOON SURPASS THAT OF HUMANS.

sometimes turn against their owners [see “Could Robots Take Over the World?,” page 59]. And with his rollicking space adventures, Heinlein pushed us into distant galaxies and far-future civilizations. The golden age of science fiction (SF, to those in the know), which spanned the 1940s and ’50s, inspired generations of kids to become astronauts, physicists and engineers, to try to make at least some of the stories real. (And those kids remember their imaginative roots: NASA, for example, sometimes calls in SF writers as consultants.)

Wandering through the exhibition room at a science-fiction convention in Boston a few months ago, I saw plenty of reprints of golden-age SF classics for sale. But I also encountered paintings of half-naked people battling dragons, vendors hawking crystals and a folk musician warming up for a recital. Where is the science in science fiction? I wondered. Whatever happened to envisioning the future? Anthropologist Judith Berman, who recently surveyed a crop of science fiction published in 1999, has a grim answer: Many modern stories are nostalgic, wary of new technologies rather than enthusiastic about them.



Yet there’s plenty to get excited about: Vinge’s vision of the Singularity springs from his own field, computer science, but change is afoot throughout science and technology. Cosmology is undergoing fundamental revisions, genetics is giving researchers the tools to rejigger the building blocks of life, and nanotechnology has begun creeping from fantasy into reality. “Several lines of progress [are] converging,” says physicist Stanley Schmidt, editor of *Analog* magazine. “You can’t lock in on one field in isolation because you’ll miss how other fields affect it.”

A new kind of future requires a new breed of guide—someone like Stross, whose first novel, *Singularity Sky*, was recently nominated for a prestigious Hugo Award, or his frequent collaborator Cory Doctorow, who in 2000 won the Campbell Award for best new science-fiction writer. Both are former computer programmers. They are computer geeks and gadget freaks. They follow engineering and materials science and biotech, not to mention politics and economics. And they have latched on to the Singularity as the idea that symbolizes our era’s rush of new discoveries. Whether their stories will usher in another golden age or inspire a new generation of dreamers remains to be seen, but their focus is dead-on. “Right now is an extremely exciting time because there’s an explosion of knowledge in biology, an explosion of knowledge in technology, an explosion of knowledge in astronomy, physics, all over the place,” says David G. Hartwell, a senior editor at Tor Books. “Right now it’s quantity, and Doctorow and Stross are the writers who are principally concerned with all this stuff.”

STROSS AND DOCTOROW are sitting outside the Chequers Hotel bar in Newbury, a small city west of London. The Chequers has been overrun this May weekend by a dis-

tinct species of science-fiction fan, members of a group called Plokta (Press Lots of Keys to Abort). The men are mostly stout and bearded, the women pedestrian in appearance but certainly not in their interests. During one session Stross mentions an early model of the Amstrad personal computer, and the crowd practically cheers. Stross is the guest of honor, and he and Doctorow have just emerged from a panel discussion on his work.

The two have met just four times, but they have the comfortable rapport of long-distance friends that is possible only in the e-mail age. (They have collaborated on several critically acclaimed short stories and novellas, one of them before they ever met in person.) Stross, 39, a native of Yorkshire who lives in Edinburgh, looks like a cross between a Shaolin monk and a video-store clerk—bearded, head shaved except for a ponytail, and dressed in black, including a T-shirt printed with lines of green *Matrix* code. Doctorow, a 33-year-old Canadian, looks more the hip young writer, with a buzz cut, a worn leather jacket and stylish spectacles, yet he's also still very much the geek, G4 laptop always at the ready.

They have loosely parallel backgrounds: Stross worked throughout the 1990s as a software developer for two U.K. dot-coms, then switched to journalism and began writing a Linux column for *Computer Shopper*. Doctorow, who recently moved to London, dropped out of college at 21 to take his first programming job, then went on to run a dot-com and eventually co-found the technology blog *boingboing.net*.

Although both have been out of programming for a few years, it continues to influence—even infect—their thinking. In the Chequers, Doctorow mentions the original title for one of the novels he's working on, a story about a spam filter that becomes artificially intelligent and tries to eat the universe. "I was thinking of calling it */usr/bin/god*."

"That's great!" Stross remarks.

Well, great for those who know that *"/usr/bin"* is the repository for Unix programs and that "god" in this case would be the name of the program, but a tad abstract for the rest of us. This tendency can make for difficult reading—one early reader of a Stross story complained that to understand it, peo-

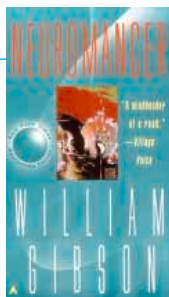
From Cyberspace to the Singularity

1984

NEUROMANCER

by William Gibson

The defining novel of the cyberpunk era, this classic introduces virtual reality to the masses. "Turing police" keep artificially intelligent entities in check.



1986

MAROONED IN REALTIME

by Vernor Vinge

Seven years before defining the Singularity in a scientific paper, Vinge explores the fate of people who isolate themselves from the accompanying technological changes.



1992

SNOW CRASH

by Neal Stephenson

Stephenson's vision of the near future, with its Internet-like Metaverse, paves the way for computer-science-influenced fiction.



1995

THE STAR FRACTION

by Ken MacLeod

MacLeod takes on the Singularity's social implications: An artificially intelligent being that arises from networked computers is central to the chaos.



2003

SINGULARITY SKY

by Charles Stross

An advanced future civilization causes the Singularity by scattering most of humanity across the solar system.



ple would have to overdose for a month on *Slashdot* (a blog that calls itself "News for Nerds"). Still, it's this fluency in computer science that allows these writers to approach the future so boldly. "Stross and Doctorow are just kind of right in there, down with their heads in the bits," says novelist Bruce Sterling, one of the original cyberpunks.

On this Saturday afternoon, much of the Plokta crowd converges in the bar, trading ideas and opinions. Some pull out laptops to take advantage of the local Wi-Fi hotspot. They remind me of Manfred Macx, an *Accelerando* character, who arrives in a new city at the start of the novel and, as his wearable computer starts streaming data, thinks, *Ah, the bandwidth is good here*. For my part, I'm feeling more like Donna the Journalist on the *Field Circus*, ruining a perfectly good day of thinking and drinking by asking questions about the Singularity.

Joining Stross and Doctorow at their table near the bar, I take advantage of a rare break in their conversation to ask, "Would the Singularity be the first such event in human history?" Collaborating on an answer, the two cite revolutionary developments such as the birth of language and the dawn of agriculture but soon agree that the Singularity would surpass all these in intensity. "The Singularity is pretty thermonuclear in terms of its finality," Doctorow says later. "It's apocalyptic in every sense of the word." Doctorow's dramatics are easier to digest in light of what Vinge has said of the Singularity: "Shortly after [it occurs], the human era will be ended"—the Singularity will usher in the "posthuman" era.

Vinge expects the Singularity to occur when machine intelligence surpasses that of humans. Life on Earth has always advanced by running simulations and adapting, he points out. Animal life does this through evolution. Humans are the one animal that has learned to do it faster, through problem solving. Sapiient machines would do it faster

still. Once our computers start to think, Vinge says, we will be "entering a regime as radically different from our human past as we humans are from the lower animals." The second trigger for the Singularity, according to Vinge, will be so-called intelligence amplification. Humans will apply their

Could Robots Take Over the World?

That's the premise of this summer's *I, Robot*. And AI researchers aren't scoffing.

Imagine a world where a robot delivers your mail, collects your garbage, cleans your house, even plays with your children. They are everywhere.

Now imagine that they turn on you.

This is the future presented in the SF thriller *I, Robot* (opening July 16), which is loosely based on Isaac Asimov's 1950 collection of short stories. In 2035, robots make up 20 percent of the population and pervade nearly every aspect of life. They are implicitly trusted because they are hardwired with what Asimov called the Three Laws of Robotics—rules that force them to protect humans above all else. The seemingly perfect circle of protection breaks down, however, when a maniacal computer brain reinterprets the three laws, reasoning that the best way to protect humans is to rule them. Standing against this strictly logical, rebellious machine is Sonny, a new kind of robot designed to evolve and learn through experience and emotion.

We're still years away from such a scenario, but the two varieties of robot featured in the movie do in fact mirror the reigning programming paradigms being pursued by today's artificial-intelligence and robotics researchers. The classical approach is to model reasoning and other forms of higher-order thinking by creating logic-based rules systems. Deep Blue, the brute-force program that beat chess champion Garry Kasparov at his own game in 1997, is the best-known example. This computational style is what governs the rebellious robots in the movie. Sonny incorporates another approach—a biologically inspired, bottom-up technique in which intelligence “emerges” as a robot encounters new problems and learns from its experiences. MIT roboticists Rodney Brooks and Cynthia Breazeal

are each building robots that learn and interact with the world from “birth.”

Over the past 20 years, the biological approach has been gaining momentum, because the classical method has proved limited in its ability to respond to complex real-world scenarios. “The problem is that logic and rules have to be applied to data,” says Roger Clarke, a computer scientist at Australian National University. Creating a data set that enables a robot to navigate a flight of stairs is one thing; making one that governs interactions with people would be devilishly difficult, Clarke explains.

As Asimov predicted, AI researchers are up against a paradox: To be truly useful, robots must be able to make their own decisions, but as soon as you give them autonomy, you give them the ability to disobey. “The more sophisticated an organism becomes, the more difficult it is to legislate rules to govern its behavior,” says *I, Robot* director Alex Proyas. “And if robots are functioning as humans do, then the rules will need to be a lot more sophisticated than Asimov's three laws.”

Which is exactly what Carnegie Mellon University machine learning expert Tom Mitchell has in mind. Mitchell imagines programming “sanity checks” into future robots so that before a command is carried out it must be run through a very complex set of laws that could override incompatible or malfunctioning commands. Robots could be reprogrammed, and the laws updated, as often as necessary.

Not everyone has faith in rules-based governance, however. Stuart Russell, a UC Berkeley AI professor, considers all the solutions proposed so far to be completely inadequate. “What's to stop some intelligent robots from getting together and rewiring themselves so that the safeguards don't work?” he asks.

For now, though, these matters remain purely academic, as reality lags far behind science fiction. Today's smartest robots hardly approach the intelligence of our pets. “We can't even build a machine as smart as a dog,” MIT Media Lab's Rosalind Picard says. “I don't think this is something we need to be afraid of anytime soon. Besides,” she adds, “we can always just pull the plug.” —RENA PACELLA



MASS
MENTALITY
I, ROBOT'S
HYPER-
INTELLIGENT
MACHINES

engineering skills to their own bodies, crossing the brain/machine interface threshold to merge with their technological creations. Implants, genetic modifications and other changes will make people smarter and give them Superman-like abilities. “It's all about transcending human limitation,” Doctorow says.

One plot device that turns up frequently in Stross and Doctorow's stories is mind uploading, in which characters create electronic copies of their brains on silicon. A technique first proposed by Carnegie Mellon computer scientist Hans Moravec, mind uploading is not to be confused with

elaborate virtual reality headsets that allow your mind to exist in a simulated environment while your body remains in the real world. Mind uploading creates an entirely separate version of you. This new you would be made of bits instead of blood; you'd be free of illness, mortality and other drawbacks of corporeal existence (such as neck pain from staring too long at a computer screen). In Doctorow's first novel, *Down and Out in the Magic Kingdom*, people create and update electronic copies of their brains the way we now back up important documents; in the event of an accident, doctors simply restore the last saved version to a new body.

Mind uploading has proved to be a particularly enticing idea to geeks wishing to transcend their cubicles and become disembodied beings of pure thought. Some aspire to the “cloudmind,” a kind of big computer in the sky where they could live out eternity—“the rapture of the nerds,” as Scottish SF writer Ken MacLeod puts it. Stross and Doctorow tend to scoff at this desire. In *Down and Out*, most of the characters remain embodied and reap the numerous technological benefits of the day. Computers and communication devices embedded in their bodies allow them to transfer files to friends through thought alone and to

it can have negative side effects. Toward the middle of the story, while she’s leading the *Field Circus* through space, Amber learns that the version of herself that remained back on Earth had a son, and that he’s suing her for child support.

The conversation in the Chequers lobby (I’d like to say “our” conversation, but most of the time I have no idea what Doctorow and Stross are talking about) turns now to computronium, another staple of Singularity fiction. Doctorow motions to the plain brown table between our chairs. If it were made of computronium, he explains, you’d have “atoms that might look like the atoms that make up this table but

are in fact doing constant microcomputation as they sit there.” The idea is that nanomachines would do the grunt work of transforming regular matter into computronium; if the process were taken to its extreme conclusion and applied to huge bodies of matter such as asteroids, you’d end up with immense “Matrioshka Brains,” mega-processors that would make Cray supercomputers seem as powerful as lunch boxes. Doctorow plans to explore the computronium idea in his novel about the artificially intelligent spam filter, which is constructed by a group of well-meaning Silicon Valley programmers. The spam filter starts to follow an agenda of its own and, no longer content to guard inboxes, embarks on a race to convert all the matter in the universe into computronium.

The steady consumption of the cosmos would be an obvious indicator that the Singularity has arrived, but Stross chooses a more metaphorical metric to track its progress in *Accelerando*. He compares the total mental capacity of the humans born each day with that of the microprocessors churned out daily on assembly lines. At the start of the second chapter, the ratio is approaching 1:1. By the fourth chapter, the processors possess 10,000 times the total computing power of humanity. Machines, not humans, now constitute most of the thinking mass in the universe.

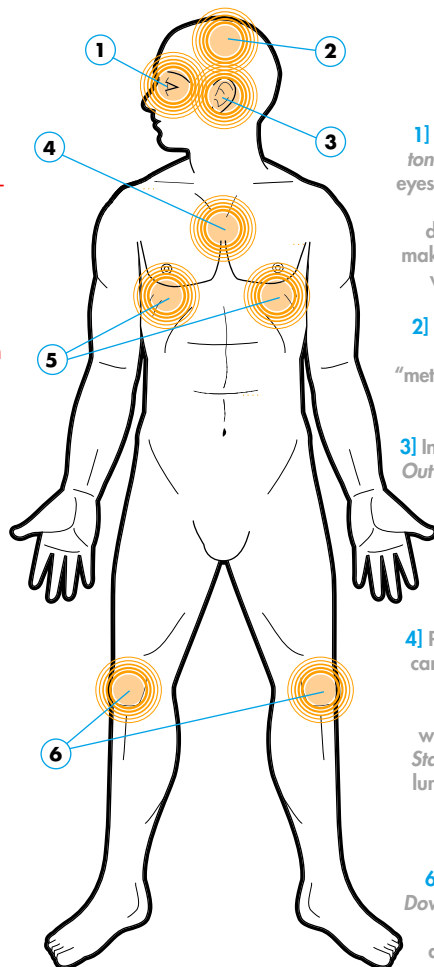
A few days before the Plokta convention, I visit Stross at his Edinburgh flat, in

a building with a stone facade and an unpainted wooden front door. He has just submitted the most recent draft of *Accelerando* to his editor. Empty mugs of tea are scattered around, the leftovers of 12-hour days of caffeine-fueled revisions. His desk is a tangle of wires and docking ports for various communication devices, his laptop perched above the fray like a tree rising from its roots. (The real reason for Wi-Fi, he says, is surfing the Web while in the loo.) The walls are bookshelves, stacked high with SF novels.

Before arriving, I had tried to arrange a science- or tech-related outing for the two of us. The University of Edinburgh, located not too far from Stross’s flat, has a well-known artificial intelligence (CONTINUED ON PAGE 92) ►

ANATOMY OF A POSTHUMAN

Science-fiction writers aren’t the only ones who think humans are destined to merge with machines, becoming synthetic hybrids. Real-world groups such as the Extropians (extropy.org) believe it will soon be possible to live forever, thanks to bodies that are more capable than the ones we are born with.



1] In Greg Egan’s *Singleton*, characters have their eyes “chipped”—computer images are projected directly onto the retina, making it possible to read with one’s eyes closed.

2] PRIMO, the Extropians’ posthuman, features a “metabrain” with enhanced memory storage.

3] In Doctorow’s *Down and Out in the Magic Kingdom*, phones ring within the cochlea of the person being called—no one else hears a sound.

4] PRIMO’s heart includes cardio-function monitors.

5] The underwater workers in Peter Watts’s *Starfish* have mechanical lungs that help them survive miles below the ocean’s surface.

6] Trendy youngsters in *Down and Out* prefer two knees per leg—and double elbows as well.

conduct phone conversations subvocally. Rings are reduced to pings that sound deep in the ear, and two knees per leg is all the rage with the young crowd.

Many of the questions this new world poses are mind-bending—for example, who “you” really are. You’ve created a copy of your brain and uploaded it, but the original you is still hanging around dirtside. The nice part, if we ever get to this point, is that you wouldn’t have to bother thinking about any of this for too long. You could just generate another copy to dwell on the question while the embodied you gets on with your life. Amber, one of the characters in *Accelerando*, frequently spins off copies of herself to tackle difficult issues. It’s an efficient way to solve problems, but



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Childhood's

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A too-brief encounter with ARTHUR C. CLARKE, the grand old man of science-fiction visionaries.

BY MATTHEW TEAGUE

Photograph by Bruno Barbey/Magnum Photos





THE GATE TO ARTHUR C. CLARKE'S compound stood tall, white and blast-proof. We ran our hands over its surface, poking around for some secret doorbell. "Hello? Can anybody hear us?"

I wasn't trespassing—I'd called ahead, and Clarke agreed to see me, apparently curious why an American would track him down to this doorstep in Sri Lanka, the tiny, troubled island nation off the coast of India. But the place spooked Thilac, my Sri Lankan driver. "Maybe wrong house," he said, looking around. "OK?"

Cinnamon Gardens is Sri Lanka's most lavish, powerful neighborhood. Clarke is the country's most famous resident. On an island where the caste system remains in force, taxi drivers don't go pawing at castle walls. When the gate mysteriously pulled back, triggered from inside, Thilac turned on his heel and walked back to his car. "You go," he mouthed from the driver's seat.

A mustached valet appeared and waved me in: "He is waiting." The main garden was barren but for the miniature headstones of pet dogs Clarke has owned during his almost five decades on the island. Dust blanketed every surface inside a glass atrium attached to the main house; sun-faded movie posters from *2001: A Space Odyssey* decorated the walls. It appeared that only house staff lived in this stale place, until my guide threw open the door to Clarke's library and a gust of cool air rushed out. The library was full of light; rows of lovingly organized books covered the walls. In the room's center sat Clarke, 87 years old and wheelchair-bound from the effects of post-polio syndrome but still spry. "Look!" he said without preamble, spinning his chair to face a bank of computers. "You must see something!"

Monitors surrounded him. One displayed a paused DVD:

IN THE CLARKE ORBIT The master spinning his visions in his Sri Lankan redoubt.

Independence Day, Will Smith's mug frozen in goofy horror. Others blinked with e-mail alerts. "Look," Clarke said again, waving for me to look over his shoulder. On one screen he summoned recent photos transmitted from Mars. He cycled through shots of an orange landscape, a mountain, a canyon. Here we sat, in this wood-paneled study, on this remote island, and, as if by magic, stared out at a Martian sunset.

The world owes that sight, in part, to Clarke's own vision as a writer and thinker.

"Beautiful, isn't it?" he said.

ONLY A HANDFUL OF SCIENCE-FICTION WRITERS HAVE reached beyond the bounds of their genre and grabbed the attention of the world: H.G. Wells, Isaac Asimov, Arthur C. Clarke. But it wasn't Clarke's lyrical prose that carried him there. His ideas did the job.

As a child in England, he explored in the way little boys often do: Dinosaurs. Chemistry sets. Science-fiction magazines. But his obsession with what lay ahead—the Big Idea—never subsided. When he was a soldier in World War II, he joined a military team attempting to harness the power of radar.

He was no scientist or inventor. But when he was 27, seemingly out of the blue, Clarke offered the world a

"Read this," he would say. "It's all in there." He could trust his words better, it seemed, when he could see them in black and white. "So," I ventured. "You've written every thought you've ever needed? No more need to speak?"

At this mild provocation he came alive. The question bumped our discussion out of the past—slippery terrain for a man in his late eighties—and into the future. He felt comfortable in the future, the home of Big Ideas.

"You've reminded me of something," he said. "How many books could ever be written?"

"Like . . . how many songs could ever be composed?"

He practically came out of his wheelchair. "Exactly! I think I worked it out one time, and it's some big number, like 10 to the power of 100 to the power of 10." I sat dumbfounded, feeling dense. He added for my benefit, "Since there are only a limited number of letters."

And so a pattern emerged in our talk, like a game. I asked a question, and he picked a random point elsewhere in the conversational universe and answered from there. Then, just when I thought he had blasted off into the void of senility, he would touch down neatly on our topic.

I mentioned cloning, a subject Clarke has written about. Halfway through my question he held up a silencing hand.

"I think of them in the night, such ideas, and think, **Did I write this?** Sometimes I find I have."

remarkable vision: satellites. At the time—1945—there was an ongoing to-do about ways to create global communication. The reigning idea was to plant television towers across countryside everywhere, an impossibly expensive and ugly notion. Then came Clarke's outrageous idea, in a paper called "Extra-terrestrial Relays." "Many," he wrote, "may consider the solution proposed in this discussion too far-fetched to be taken very seriously."

Rockets, he suggested, could carry into orbit lightweight units that could act as superhigh relay towers. Two decades later, when the world caught up, scientists named what we now call the geostationary orbit the Clarke Orbit.

DESPITE THE LUXE SURROUNDINGS—THE MANSION, THE attendants, the reminders of his fame and influence—Clarke opened our conversation with a disarming nervousness. He fidgeted, toying with his eyeglasses, playing with my tape recorder. Time has claimed pieces of his memory, and he seemed aware of it. When I asked about his latest book, a collaboration with science-fiction writer Stephen Baxter, he looked down sheepishly and said, "Yes . . . *Time's Eye* . . . What was that about?"

For a while he wouldn't reply to my questions at all but instructed me to direct them to his Sri Lankan assistant. ("He can answer all these," Clarke said. "I can hardly talk.") Later, instead of speaking aloud, Clarke flipped through his older books for passages relevant to our conversation.

He mumbled something to his assistant, who handed him a snapshot. "I'm still crying," Clarke said, passing the photograph over to me, and his lower eyelids went liquid. "I lost her last week."

The picture was of a Chihuahua, whose name, he said, was Pepsi. "I'm going to get another one today," he said.

"Another Chihuahua?"

"Yes. Oh yes. The same one again."

Talking with Clarke was like spending time with a prophet. No answers came easily, and when they did come they often took the form of parables. Rather than entangle himself in a long argument over the ethics and viability of cloning, he simply handed over a picture of his beloved Chihuahua—a fine candidate, one might infer, for cloning.

AS A YOUNG MAN, CLARKE WAS PALS WITH SOME OF Britain's fastest-rising literary stars, including C.S. Lewis and J.R.R. Tolkien. That was before he made a name for himself in 1953 with *Childhood's End* and before he fell in love with the Indian Ocean's coral reefs. "I came for the sea diving," he told me of his move to Sri Lanka in 1956. "Underwater was the closest I could come to the weightlessness of space."

While we talked, something reminded him of his London days, and although he could hardly recall his latest book, conversations from decades ago still rang clear in his mind. "C.S. Lewis! I just remembered our parting words," he said. "We were at a pub. The Eastgate. Fleet Street." He leaned back in

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his chair, chasing the memory down the street and finally cornering it. “Ah,” he continued. “As we staggered out into the street, Lewis turned to us. He said, ‘I think you are very wicked people, but wouldn’t the world be a dull place if everyone was good?’”

Clarke laughs uproariously at this gentle rebuke, slapping his desk and shaking his head. Lewis is the most widely read Christian apologist since the apostle Paul, and Clarke is surely among the most widely read opponents of faith. “Religion is the most malevolent of all mind viruses,” Clarke declared, warming to the topic.

“Wow,” I said. “That’s not a very . . . generous . . . view of religion.”

“Most malevolent and persistent of all mind viruses. We should get rid of it as quick as we can.”

“So,” I said, extrapolating, “do you think that ultimately religion will be banished like a virus? A vaccination against religion, maybe. Could be an interesting book.” There was a silence as Clarke appeared to mull over the concept, and then: “I’m working on the novel now,” he said. “I don’t know how many of these ideas I’ve actually used already. I think of them in the night, such ideas, and think, Did I write this? Sometimes I find I have.”

CLARKE’S TURN TO DAZZLE THE world came in 1968, when he shared an Academy Award with Stanley Kubrick for the film version of *2001: A Space Odyssey*, which was inspired by a 1951 Clarke story. In it he laid out, with wizardlike foresight, several notions that time would validate: Videophones. Lunar landings. The Internet. Before long, Clarke was co-broadcasting Apollo missions with Walter Cronkite.

Now I asked whether he expects computer intelligence to one day intercept human intelligence, as he predicted in *2001*. He laughed. “Assuming it hasn’t already?”

Gently, I eased into an attempt to get Clarke to issue a few more predictions for posterity. “You were way ahead in your understanding of satellite orbits,” I said, “so where do you think communications will go next?”

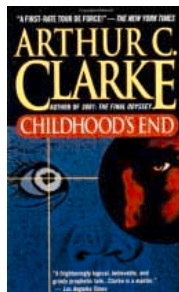
“Well, brain to brain, obviously.” He described something he calls a “brain cap,” by which people could swap thoughts in the air. Instead of blowing a kiss to your spouse at the airport, you could blow him or her an entire farewell letter, with

The Manifold Futures of Arthur C. Clarke

1953

Childhood’s End

An alien invasion ends war, hunger and poverty, but humanity enters a state of creative torpor, watching—get this!—three hours of TV a day.



1968

2001: A Space Odyssey

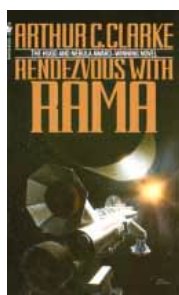
The computer on board the *Discovery* embodies the perils of human-level artificial intelligence. Hal 9000 runs the ship but, inconveniently, is also prone to murder.



1972

Rendezvous with Rama

Spurred by an asteroid strike in Italy, humanity launches a search for future doomsday rocks. The strangest find proves to be a mysterious cylindrical ship.



1979

The Fountains of Paradise

An engineer attempts to build a 24,000-mile-high space elevator to ferry materials into orbit. Humanity is in an era of technological prowess; a bridge over the Strait of Gibraltar is mentioned incidentally.



photos and audio clips. Brain caps, he explained, would also eliminate menial tasks. “I think it’s imminent,” he said, “for some simple things like switching lights on, or the air conditioner, or starting your car.”

When might the brain cap emerge as a viable tool? “Well, it depends what bandwidth you’re talking about!” he replied, laughing. He got the faraway look that signaled the arrival of another Big Idea. “Ultimately it’s sort of a total merging of two minds. So you don’t even know who you are. . . . Maybe 10 years.”

As his predictions kept coming, Clarke developed a running joke about all the exciting developments that would happen roughly 20 years from now: Cryogenic freezing? Who needs it? We’ll bypass the body and upload our essences to computers—if we so choose—about 20 years hence.

We’ll also ride elevators into space soon, he said. It’s one of his favorite predictions, one he has trotted out for years. “When?” I ask. Oh, in 20 years.

Also at about that time, nanotechnology will allow us to retool the atoms in common lead and turn it into gold. But lead will become more expensive than gold because it is more useful. This radical reconfiguration of value will lead to the abolishment of money as we know it, and instead people will trade megawatts as currency.

What about interplanetary tourism? Sure! Twenty years. “What a year that’ll be,” he said, grinning. Ah, but we may not make it that far, he added. Because the end of the world just might arrive at about the same time.

It’s a sobering prediction. And so, sitting with this unsettling man in this exotic land, a final question occurred to me: If humanity does find itself in extremis, what will be Arthur C. Clarke’s message when

we turn to him for guidance?

Clarke dwelled on the thought a moment, smiling. He seemed to relish the idea that he would still be around in 20 years—and even better, that the human race would come to him for one last word of instruction.

Well, take heart, people, because in these twilight hours he decided to keep it simple:

“Don’t panic.” ■

Writer Matthew Teague lives in Fairhope, Alabama.



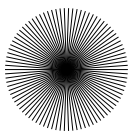
WINGTIP TO WINGTIP AT 450 MPH 30 FEET ABOVE THE GROUND! SIDEWAYS!

IT'S THE
WORLD'S
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CAN THEY
MAKE
AIR RACING
RELEVANT
AGAIN?

BY CARL HOFFMAN
PHOTOGRAPHS BY
JOHN B. CARNETT



RACIN' AWAY Jon Sharp (top) and Darryl Greenamyer (above) will battle head-to-head in this year's Reno Air Races. At left, two planes in the Unlimited class square off.



AS DARRYL GREENAMYER APPROACHED THE LAST turn in the final Sport-class race of the 2003 National Championship Air Races in Reno, Nevada, he heard a sound. It was a roar, really—so loud it seemed to come from inside his plane, just behind his head. Greenamyer was flying 40 feet above the ground at something faster than 320 mph. But Rick Vandam was passing him.

Over the course of 38 years, Greenamyer has won nine championships at Reno. There is nothing he hates more than second place.

This was air racing, not auto racing, and so the incursion was happening in an ever-changing three-dimensional space, Vandam coming from slightly below and to the right, on the “outside” of the track. “I couldn’t see him, but I could hear that he was really close,” Greenamyer says. He had blown out his souped-up racing engine in a heat race the day before and had stayed up all night replacing the cylinders with stock parts. And now here he was, hobbled, underpowered, getting passed. The two planes hit the turn. Greenamyer banked hard to the left around a pylon—his plane was almost sideways—looked down, and saw Vandam’s shadow pulling ahead on the outside. “Here goes my second engine,” Greenamyer thought, driving the throttle forward and praying that Vandam wouldn’t be able to turn as tightly (or fly right into him), and that his stock engine would hold. It did. Greenamyer won the Sport class by 1.9 seconds.

“It was actually an exciting race,” Greenamyer says, somewhat incredulously, six months later, standing next to his shiny red plane—minus wings and engine—in his San Clemente, California, workshop. “And I don’t intend to let it happen again.” He is 67 years old, a compact man with white hair, dimples and twinkling blue eyes. He looks harmless. But Greenamyer is a former Lockheed Martin test pilot who, back in the 1960s and ’70s, flew the CIA’s A-12 spyplane and its successor, the SR-71. When many of us were listening to Grand Funk Railroad on our eight tracks, Greenamyer flew from California to Florida in 58 minutes. He broke the piston-engine speed record in 1969 and the low-altitude jet speed record in 1977. He once tried to take wing from a frozen lake in northern Greenland in a World War II-era B-29 that hadn’t been flown in 48 years. He is notorious for doing things in and with airplanes that ordinary people wouldn’t even think of, and he has won the fastest division of the world’s fastest motor sport more times than anyone.

Over four days every September in Reno, pilots race wingtip to wingtip around 40-foot-high pylons, a throwback to the golden age of aviation in the 1930s. Traditionally, there were four classes of planes in competition: T-6s—World War II-era trainers whose speed reaches 230 mph; biplanes—small, single-seat machines that reach 200 mph; Formula One—tiny, custom-made planes powered by 200-cubic-inch engines that reach lap speeds of 250 mph; and the Unlimiteds—planes whose engine horsepower is unrestricted. The Unlimited division is what Reno is famous for—the speed,

noise and danger of former top-of-the-line World War II fighters such as P-51 Mustangs flying lap speeds of 450 mph within shouting distance of the ground.

And it’s the Unlimited division that Greenamyer has won seven times, the first in 1965 and the last in 1977. His winning plane, a highly modified Grumman F8F-2 Bearcat named *Conquest I*, weighs 6,000 pounds, has eight feet clipped off its wings, the oversize prop of a Douglas Skyraider and a massive 3,200-hp engine. It now sits enshrined in the Smithsonian National Air and Space Museum in Washington, D.C.

Right beside it, dwarfed in its shadow, rests a 520-pound Formula One plane called *Nemesis*. There is only one pilot whose legend at Reno rivals that of Greenamyer, and that’s Jon Sharp, an advanced-composite engineer at Lockheed Skunkworks who flew this tiny plane to nine consecutive Formula One-class wins. Before its retirement in 2000, *Nemesis* broke every record in its division; the plane was so successful that competitors routinely tried to sabotage it.

Sharp and Greenamyer are the most successful pilots in Reno history. They’re both gifted race pilots with an intuitive sense of what it takes to make a plane go fast, and they both hate to lose. Now, in shops 150 miles apart—Greenamyer’s in San Clemente, Sharp’s in Mojave—the two legends are putting the finishing touches on their latest creations. In September they will go head to head for the first time ever, each flying small, light, high-tech machines in a division that didn’t exist at Reno until five years ago, a division that threatens to dethrone the mighty Unlimited warbirds in excitement, technology and maybe even speed, and in the process might make the sport of air racing relevant for the first time since the 1930s.

THERE’S A REASON GREENAMYER was so incredulous at finding himself in a contested race last year at Reno—and it goes beyond

mere hubris. But to understand it requires a bit of history.

In the 1920s and ’30s, air racing was wildly popular, its pilots household names like Jimmie Doolittle who drew hundreds of thousands of spectators to venues such as the National Air Races in Cleveland, Ohio. As in auto racing today, the machines they flew pushed the boundaries of technology and design and broke records annually. Pylon air racing was cutting-edge sport and technology, and watching it was hip.

Then came World War II, which suspended the sport and accelerated the technological development of aviation in ways no one could have imagined. In 1939 America’s fastest fighters flew little more than 300 mph. Just five years later, Mustangs and Corsairs were hitting speeds nearly 150 mph faster; by war’s end they were the fastest machines on Earth and



THE MODIFIER



NEW BREEDS Above: Greenamyer in a heavily modified Lancair Legacy shortly after winning last year's Sport Gold race. Below: Sharp and the *Nemesis NXT*, in Mojave, California, earlier this year. Opposite page: Greenamyer in 1966, days before winning the Unlimited class for the third time in the then three-year history of the event (top); Sharp and *Nemesis* in 1998, after he bested his own speed record by 6.5 mph (bottom).

THE BUILDER



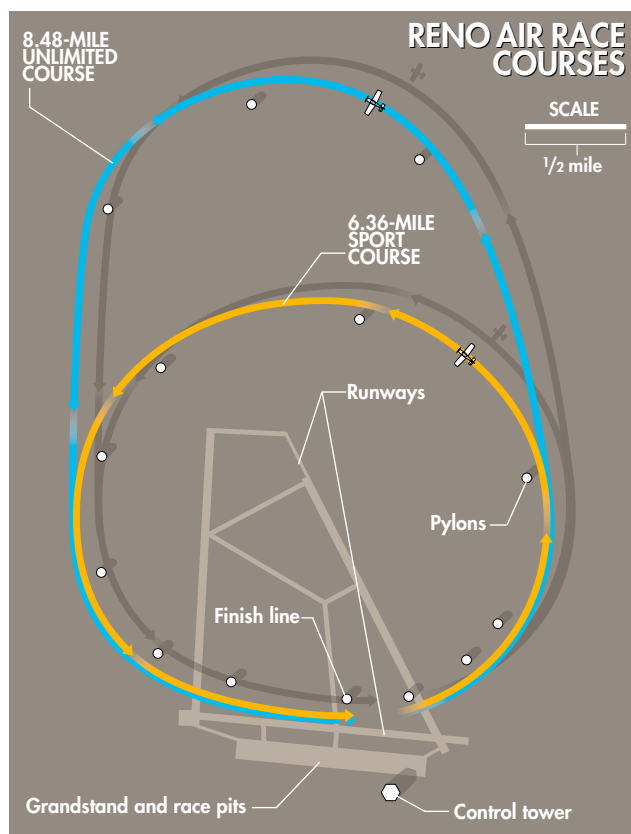


TAILGATING Jim Eberhardt (no. 30) and John Zayac (no. 12) cut it close during the qualifying race for the T-6 competition in 2003.

there were tens of thousands of them out there. Piston and propeller technology, it seemed, had reached its apex. When air racing resumed, its allure was on the wane; airplanes were as familiar as automobiles, and there were no technological boundaries left to be pushed. Then, at Cleveland in 1949, Bill Odom crashed into a house at the end of the course, killing a mother and her child. Air racing was over.

In 1964 a cattle rancher named Bill Stead resurrected the sport over a patch of desert outside Reno. Hardcore working pilots like Greenamyer, then flying for Lockheed, loved to fly

MAIN COURSES Reno has no single racecourse—rather, competitors from the six different classes race around 40-foot-high pylons set in the desert surrounding Reno Stead Airport. The two longest and fastest courses, shown below, are for the Unlimited and Sport races.



fast and to tinker, and their planes of choice were warbirds—not because they were crowd-pleasing icons but because, as surplus World War II junk, they were the fastest and cheapest planes money could buy. Greenamyer's Bearcat was valued at \$8,000; new engines and aviation fuel could be had for next to nothing. He chopped off the wingtips, streamlined the cowl, added a huge prop and cooling system, and dramatically reduced the plane's weight. Nobody could touch him. Reno grew slowly into an aviation cult, until the ritual packed in 150,000 fans a year. There is simply nothing like a pack of fighters roaring wingtip to wingtip 30 feet off the ground at 450 mph. But with every passing year, the Unlimited field becomes less competitive, with little wingtip-to-wingtip action anymore. The reason is the economics of scarcity.

Today only a handful of Bearcats and Mustangs remain. Of 50,000 Rolls Royce V-12 Merlin engines produced during the war, less than 1,000 are left. A stock Mustang is an antique worth \$1 million; chopping it up to win at Reno the way Greenamyer did with his Bearcat could easily cost an extra \$500,000, all to create a plane that would race one weekend a year and whose likelihood of crashing or blowing a rare \$250,000 engine would increase exponentially the faster it went. And first place grosses you only \$160,000.

The numbers tell the story. In 20 years, lap speeds have barely increased. Out of 26 planes in the Unlimited division in 2003, 197 mph separated the first and last place qualifying speeds. Even in the final heat, the speed differential between first and third place was 40 mph. "There are only two or three real Unlimited race planes now," Sharp says. "The rest are just tweaked-up warbirds whose rich owners want to win trophies for competing. If you own a P-51 Mustang, you don't want to really race it hard. And it's all just about horsepower anyway. There hasn't been any new technology in 40 years."

"I call it gentlemen's racing," Greenamyer says.

Over the years, a few people have tried to create custom-made Unlimited racers to inject speed and excitement into the division. Greenamyer once pitched Cessna a wild idea: He'd fly a dowdy Cessna 210 with a massive 12-cylinder engine. Worried about liability, Cessna declined. A radically altered P-51 killed pilot John Sandberg in 1991. Two years later Burt Rutan's \$2 million custom-made *Pond Racer* crashed in qualifying, killing pilot Rick Brickert. Gary Levitz, the discount-furniture magnate, cobbled together a Mustang fuselage and the wings of a Learjet; he died in a fiery crash at Reno in 1999. In Greenamyer's own shop sits the most revolutionary Unlimited plane of all: *Shockwave*, sporting a custom fuselage, the stubby outer wing panels of a World War II-era Sea Fury, the tail of an F-86 jet and a massive 28-cylinder Pratt and Whitney R-4360 built to power long-distance bombers and capable of pouring out 5,000 hp. But *Shockwave* has been left unfinished for more than 15 years. Finding the million dollars necessary to put it all together has proved impossible, given that the plane would bring home just 15 percent of that figure if it won.

The Holy Grail in any type of racing is corporate sponsorship. But what kind of company would sponsor a Mustang or a Bearcat—or, for that matter, a T-6, a biplane or a one-off Formula One the size of a telephone booth? Auto racing sells cars: "Race on Sunday, buy on Monday." But no Joe Six-pack in the stands at Reno can go out and buy any of those planes.

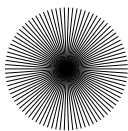
Meanwhile, though, a quiet aviation revolution has taken place. Throughout the 1940s, '50s and '60s, corporate giants such



RENO 911 Above: After decades of decline, relatively cheap and fast kit planes could resurrect pylon racing, still seen every September in Reno. Below: Wayne Cartwright in *Six Shooter* takes a typical racing line at last year's event—low, fast and tight.



WIN RENO, GO SUPERSONIC



DAVID ROSE WANTS TO MAKE A SPLASH AT Reno this year, followed by a bang—or rather, a series of excruciatingly loud bangs. He is racing what he hopes will become the first propeller-driven aircraft

to break the sound barrier in controlled flight—a feat that will make so much noise and produce so little tangible benefit that he doubts anyone will ever attempt it again. “I won’t achieve anything,” says Rose, a steely-eyed 67-year-old. “It’s just one of those things that should have been done many years ago but hasn’t.”

It hasn’t been done for good reason. In the 1950s the U.S. Air Force flight-tested a jet-engine-powered, propeller-driven fighter called the XF-84H, but the “Thunderscreech” proved so monstrously loud that it actually made people ill. With less power and a much smaller prop, Rose’s plane, *Renegade*, should be quieter—but not much. With four propeller tips, each going supersonic simultaneously, and a roaring 1,700-hp



engine, “it’s going to be mind-bendingly noisy,” aerodynamicist Barnaby Wainfan says.

Taking a propeller-driven plane to Mach 1 also presents other, more critical problems, such as how to cram a massive engine into a tiny airplane. Rose had to scrap the original fuselage because the engine’s enormous torque twisted it excessively. To stiffen the airframe, Rose designed a new fuselage around a cage of chrome-moly tubing, like that used by drag racers. “I could comfortably crash this at 300 mph,” he says.

Ideally, Rose won’t have to, but the challenge of piloting such a light, powerful prop plane can’t be overlooked. One of the biggest technical issues is managing the torque of the engine with *Renegade*’s tiny wings. When the engine is revving high at low airspeeds—as it would during takeoff—the whole package could prove uncontrollable.

Rose plans to race *Renegade* at Reno this fall, win the heavyweight Unlimited class, and impress a potential sponsor enough to fund the \$150,000 upgrade from the current 1,200-hp engine to a 1,700-hp replacement. If all goes according to plan, by next summer he’ll be piloting the push-prop beyond Mach 1. —JEFF WISE

as Cessna and Beech built general aviation planes to rigorous FAA standards, and they all looked pretty much alike. There was one loophole to the FAA regulations, however: so-called homebuilt aircraft, at least 51 percent constructed by their owners for research or recreation. Into the early 1970s, homebuilts were sold mostly as time-consuming, complex plans for airplanes that were difficult to make and didn’t fly very well when finished.

Then along came aviation pioneer Burt Rutan. When he saw European soarers building fiberglass-covered foam-core gliders, he adopted the technology to build the VariEze in 1976. It was light and sleek and flew 180 mph—30 percent faster than a Cessna 172—yet was much simpler to build and safer to fly than previous kit planes. Within four years the Rutan Aircraft Company sold 4,500 kits; today a VariEze hangs in the Smithsonian, and the composite homebuilt movement is the single most vital piece of the general aviation market. Simply put, carbon fiber allows for an airframe that is light and strong, with nary a rivet, in an aerodynamically efficient shape that is relatively easy to build. “There have been more sports planes registered by far in the last decade than certified factory-built general aviation airplanes,” says Roger Pascoe, senior vice president of operations for Textron Systems, which makes Lycoming aircraft engines. Companies such as Lancair International, billing itself the “Ferrari of homebuilts,” are churning out kits for sophisticated, pressurized, four-seat kit planes capable of crossing the country with one stop at 300 mph, for half the price of a Cessna that delivers half the performance.

With kit planes selling like iPods, Reno ultimately sensed an opportunity it had found with no other class, the opportunity to get much closer to the “Race on Sunday, buy on Monday” paradigm—“a chance to bring current manufacturers of airplanes and parts into racing,” as Michael Houghton, president and CEO of the Reno Air Racing Association, puts it. “It’s a model that works well for Nascar.” Lancair offered to sponsor the first Sport-class division race in 1998. It entered a factory-built plane and won.

DARRYL GREENAMYER WAS THERE THAT YEAR, WATCHING. He was in the market for a new plane to just fly around in, so he wandered into Lancair’s display tent, where its newest plane, a fast two-seater called Legacy, was on display. “I’m interested in buying one,” he said. Sure, the saleswoman said, put your name on the waiting list. Never one to wait, Greenamyer offered another suggestion: “What if I race it?”

“Who are you?” asked the woman.

The rest is air-racing legend. Lancair allowed Greenamyer to buy kit number one in 2000, and today the plane sits in his San Clemente shop in the midst of yet another round of modifications to make it go faster. (So far, the only limiting factor in the Sport class is a maximum engine size of 650 cubic inches and a requirement that at least five kits be sold for each model entered.) Lancair had no idea what it was getting into when it started cavorting with Greenamyer. Back in his Unlimited days, the old Bearcat had been so radically modified that it could barely stay in the air; the cockpit temperatures reached 200°F, and Greenamyer flew with an ice pack strapped to his chest to cool his hands. After setting his piston-engine speed record in 1969, Greenamyer assembled the (CONTINUED ON PAGE 94) ►



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THEY SHOULD HAVE LEFT HIM ALONE

THE
BOURNE
SUPREMACY

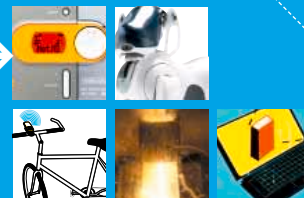
MATT DAMON IS JASON BOURNE

UNIVERSAL PICTURES PRESENTS A KENNEDY/MARSHALL PRODUCTION IN ASSOCIATION WITH LUDLUM ENTERTAINMENT MATT DAMON "THE BOURNE SUPREMACY" FRANKA POTENTE BRIAN COX JULIA STILES
KARL URBAN GABRIEL MANN AND JOAN ALLEN MUSIC BY JOHN POWELL COSTUME DESIGNER DINAH COLLIN EDITORS CHRISTOPHER ROUSE RICHARD PEARSON PRODUCTION DESIGNER DOMINIC WATKINS DIRECTOR OF PHOTOGRAPHY OLIVER WOOD
EXECUTIVE PRODUCERS DOUG LIMAN JEFFREY M. WEINER HENRY MORRISON BASED ON THE NOVEL BY ROBERT LUDLUM PRODUCED BY FRANK MARSHALL PATRICK CROWLEY PAUL L. SANDBERG SCREENPLAY BY TONY GILROY DIRECTED BY PAUL GREENGRASS
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HOW2.0

YOUR LIFE ON TECH

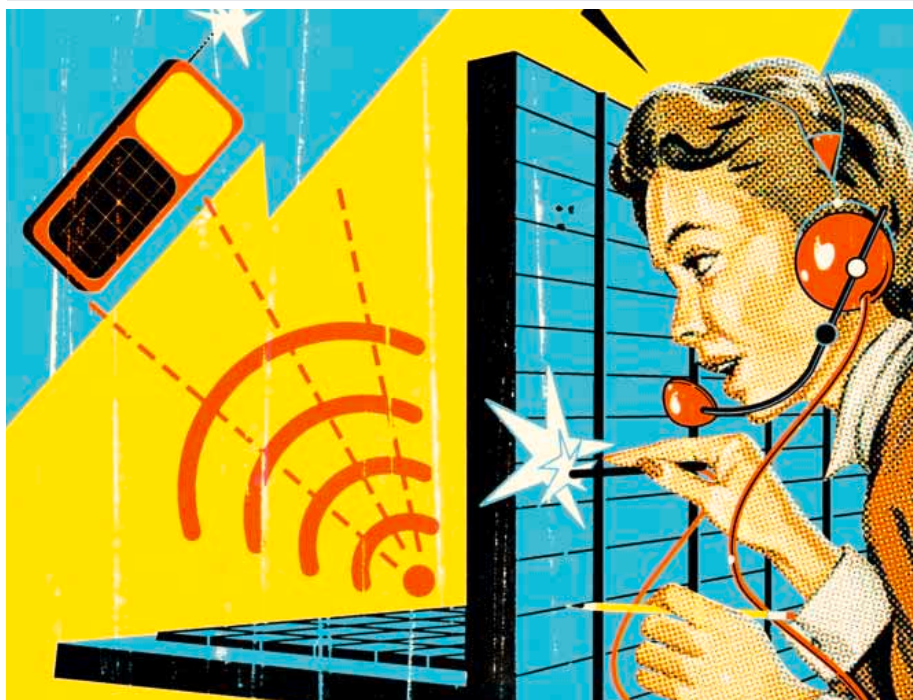
HACKS, UPGRADES,
PROJECTS, GRIPES,
TIPS & TRICKS



THIS MONTH

GROK
OGLE
BUILD
HACK
ACQUIRE
INTEGRATE
EXPERIMENT

- Lose the landline and go VoIP **75**
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- Making molten metal from magnetite **82**



• 5 THINGS... TO DO WITH YOUR CELL ON YOUR SUMMER VACATION

1 GET DIRECTIONS

Nextel's Telenav is the first service that uses the GPS chip in your phone to get you from where you are to where you're going. Just say your destination and receive spoken or text turn-by-turn directions to any location in the U.S. except Alaska.

2 FIND FRIENDS IN THE AREA

Dodgeball is like Friendster with a point. Register at dodgeball.com, then text the site with your whereabouts and it will alert you if any friends or friends of friends are within a 10-block radius. Those with cameraphones will even get a photo. Currently available in Boston, New York and eight other U.S. cities; more by this fall.

3 BUY PEANUTS AND CRACKER JACK

For a small surcharge, several minor-league and college baseball stadiums now let you order dogs, pizza and soda straight to your seat with your Web-enabled phone.

4 SHARE YOUR PICS

Don't wait till you get home to bore family and friends. Set up a free moblog (that's "moe-blog," as in mobile blog) at textamerica.com and post your cameraphone pics, as well as text and even video, from anywhere you get a signal.

5 TAKE AN EXTRA DAY OFF

Join the Alibi and Excuse Club at sms.ac and send a text when you're in a jam—club members will call or text your boss (or anyone else) with an airtight excuse for you. —KATE ASHFORD

DEPT: Geek Guide INVESTIGATOR: Nicole Davis

TALK BECOMES CHEAP

FINDINGS: Ditch that fee-laden landline. VoIP—routing calls over the Internet—is finally a viable alternative.

TECH: VoIP
COST: Free to \$40
per month

Beta |||| Final

► **Landlines are so 2003.** Four million people worldwide now use voice over Internet protocol (VoIP) to route their calls over the Internet and private networks instead of over dedicated phone lines. All you need is an adaptor that sits between your phone and your high-speed connection and magically transforms your conversation into byte-size digital packets and back to voice again. The quality is better than your cell and often as good as your landline, with a gazillion included features, for less money than you pay now (see "Plan Prices," next page). You can even keep your phone and number. So why aren't we all using VoIP?

For starters, you need broadband, and a surprising half of all connected Americans still plod along with dial-up. Also, local area codes aren't yet available everywhere. Other hurdles: VoIP lines die when the power does, not all providers support 911, and there are theoretical security risks (call tapping, voicemail spam), although most providers have, or will soon have, protection against these threats. (Skype already uses 256-bit encryption that >>



even the FBI can't crack.) Kinks, sure, but nothing that can't be ironed out over the next decade as everyone from SBC to Verizon upgrades to an IP network. (Of course, by then VoIP will probably be regulated to death and riddled with fees.)

Your best bet: get in now. Already, dozens of providers—from Baby Bells such as AT&T to indies like Vonage and BroadVoice—offer paid service that routes calls partway over the Internet and then joins the regular PSTN network, so you can call any phone in the world. And if you're not ready to take that plunge, you can try VoIP free, calling other VoIP users through your PC.

PLAN PRICES

All prices are monthly and include unlimited local and long-distance calling, as well as a full suite of features. And forget all those fees and surcharges—the only thing added to these prices is tax.

CALL ANYONE VoIP

- >Time Warner Cable Digital Phone, \$40; timewarnercable.com
- >AT&T CallVantage, \$35; usa.att.com
- >Vonage, \$30; vonage.com
- >Voice Pulse, \$25; voicepulse.com
- >BroadVoice, \$20; broadvoice.com

STANDARD LANDLINE

- >AT&T OneRate USA, \$46 (in New York City); choice of three features



1 PAID SERVICES: CALL ANYONE

SETUP Most companies require you to sign up online and do your own installation. Pay the start-up fee of around \$30, and the provider will send you an adaptor with instructions on how to rig your home phone to their network. I won't kid you, this can be a pain: you may need a router to bridge your computer to the adaptor, or a cordless phone with multiple handsets to distribute a single VoIP line throughout the home. Fortunately, once it's done, your computer never has to be on while you talk.

QUALITY In six months of using Vonage service, I occasionally experienced minor jitter in conversations or a pause before my calls went through. AT&T's CallVantage seemed immune to these problems in the month I used it, as did BroadVoice (though I was once told that my words were "clipped"). From my end, the fidelity on all three sounded as good as my old landline, but as I'm mostly calling cells and cordless phones these days, I admit I don't even remember what pin-drop clarity sounds like.



2 FREE SERVICES: CALL OTHER VoIP USERS

SETUP Start by downloading the provider's softphone—an application that gives you a virtual dial pad or IM-like interface with which to place calls. To begin chatting you'll need a USB headset or a converter that connects your regular phone to your PC.

QUALITY Luxembourg-based Skype (skype.net) allows you to call only other Skype users, but once you download the spyware-free software and connect, you will be blown away by the clarity. One Canadian caller I spoke to says his Skype conference calls to Tanzania, Germany and Estonia are so clear he never misses a vowel. (Skype recently added a paid service that allows you to call any phone but says it will maintain its free PC-to-PC version.) FreeWorldDialup (freeworlddialup.com) is more versatile. You can call 800 numbers and VoIP subscribers on other select networks, using a Mac or a PC. The catch: Sound is tinny compared with Skype's, and calls are often dropped. Even when it's free, a bad connection just isn't worth it.

EARLY ADOPTER

A FIRST LOOK AT FUTURE TECH

We just moved to a new city, separating two-and-a-half-year-old Lucy from Grandma and Grandpa. Now their visits send her into irrepressible paroxysms of delight. Grandma and Grandpa miss her too, their stiff upper lips quivering just a bit at the end of phone calls.

Enter PopSci Dad with the WorldGate Ojo videophone, a

WORLDGATE OJO VIDEOPHONE

\$700 each, motorola.com

LEAP FORWARD: Seamless real-time video and audio

REMAINING HURDLE: Cost



VoIP-based device coming from Motorola this fall that transmits a TV-like 30 frames per second. Although it's aimed primarily at businesses (a pair costs \$1,400), I hoped it would work as well in a living room as a boardroom. Based on Lucy's wide-eyed reaction to first seeing Grandma's happy mug on the 7-inch LCD screen, the answer is a definitive yes. Grandma got the ball rolling by asking what Lucy did that day. "We went to the playground!" she shot back, instinctively holding up a small, unrelated toy to show Grandma. "Ooooo, look at that!" Grandma cooed.

Set-up was plug-and-play. Video and voice were perfectly in sync, and there was no child-scaring pixelation or low-framerate jumpiness. The phone worked so well that it quickly became invisible to Lucy—she simply saw Grandma.

My one complaint: The eye-level vertical screen should rotate. It'd be nice to squeeze Grandma in too. —ERIC ADAMS

Unique VoIP features:

- > Receive your voicemail via e-mail as .wav files. BroadVoice and AT&T let you permanently delete them from your inbox or your phone, so you only have to do it once.
- > With a softphone from Skype or Vonage on your laptop, you can make calls from any Internet connection in the world. Domestic long distance is free, and international rates are as low as a few cents a minute.
- > AT&T's "Do Not Disturb" feature lets only emergency calls through and can be activated over the Internet or scheduled to begin and end at set times.
- > Choose your area code, swapping your 212 for a 415 if you live in New York but mostly call the Bay Area.
- > BroadVoice offers a Wi-Fi phone, which lets you talk over any free hotspot. By next year, Motorola will offer a hybrid cellular Wi-Fi phone that will roam seamlessly from one network to the other.



Honda's idea of sitting around all weekend.

The AquaTrax from Honda. Grab your friends and family and make a splash with the world's most advanced lineup of four-stroke personal watercraft, featuring two turbocharged models. Whether you choose our two-seater or three-seater, you'll get all the performance you expect from Honda. And maximum fun every weekend.



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DEPT: You Built What?! INVESTIGATOR: Mike Haney

TAKING IT TO THE STREETS

FINDINGS: Got something to say? With this SMS-printing bike, anyone can leave a message in New York.

TECH: Message-spraying bike
COST: \$200 (excluding bike, laptop and cell)
TIME: 6 months

Practical Popcorn

Josh Kinberg just finished his master's thesis and hit Print. It read only "I Love New York." His adviser loved it.

Of course, Kinberg's degree is an MFA in Design and Technology from Parsons School of Design in New York City, and his thesis is a bicycle that receives text messages and prints them in foot-high chalk letters, then blogs a digital photo and GPS map of the printing, all while the rider cruises along.

A self-described "hacktivist," Kinberg's other school projects

have included Magicbike (a mobile Wi-Fi hotspot he and a professor take to outdoor cultural events) and the Hello World Project, which let people laser-project their own messages onto landscapes and landmarks all over the world.

Kinberg will officially roll out the bike during August's Republican National Convention in New York, but he says the project is as much performance art as protest. The project homepage can be found at bikes.againstbush.com. See video of it in action at popsci.com/h20.



FROM WEB TO STREET:

- > **1 Nokia 3650 cellphone** receives a text message sent from Kinberg's site. If the rider wants to print it, he sends it via Bluetooth to a Powerbook.
- > **2 AppleScript and Perl code** translate each letter into a 5-by-5 dot-matrix pattern and

send binary code to a black box containing a BASIC stamp microcontroller.

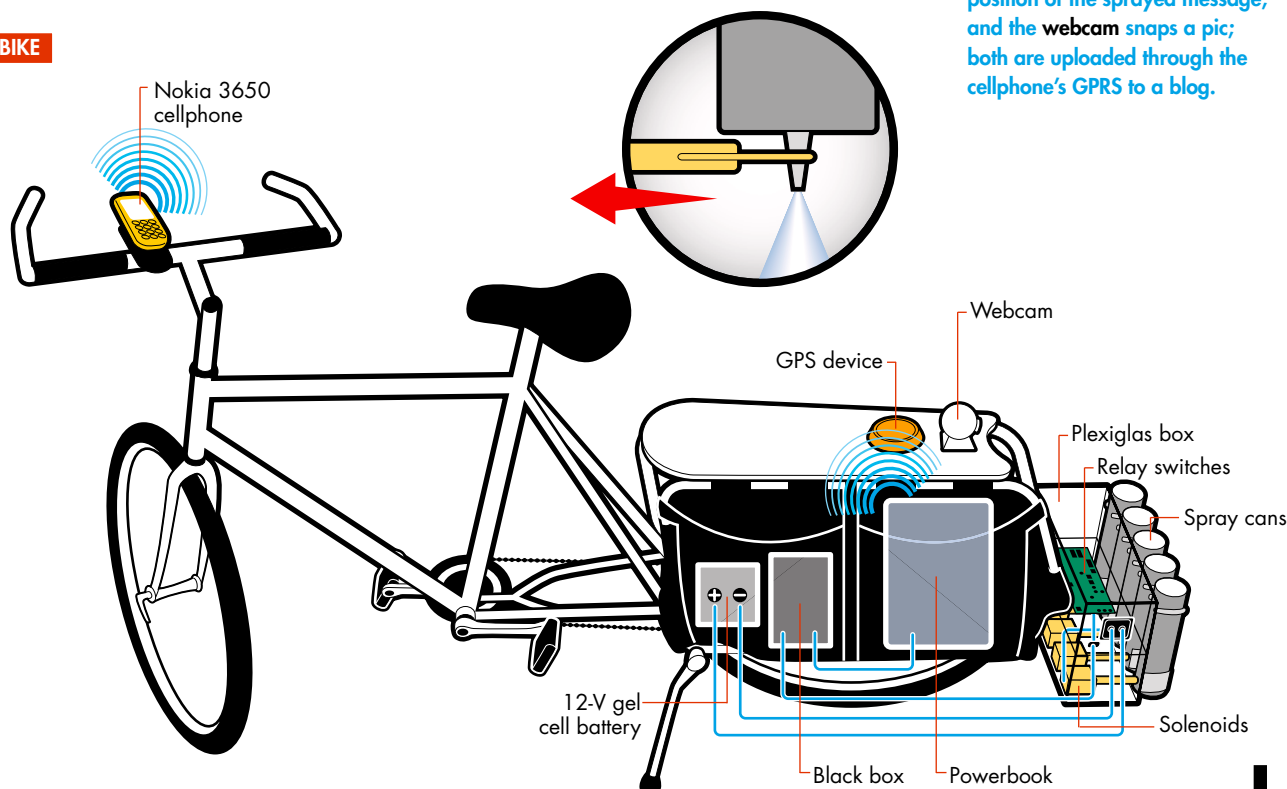
> **3 Code is translated into high- or low-voltage signals, and sent via homemade serial cable to five relay switches housed in a custom-made Plexiglas box.**

> **4 Relays fire electromagnetic solenoids, powered by a 12-V gel cell battery.**

> **5 Solenoid pistons trigger nozzles on inverted spray-chalk aerosol cans to blast out a dot. The rate of fire adjusts automatically based on the rider's speed.**

> **6 GPS device captures the position of the sprayed message, and the webcam snaps a pic; both are uploaded through the cellphone's GPRS to a blog.**

THE BIKE



• Procurement Dealnews.com

→ Only suckers pay retail, especially when it comes to tech. My favorite source for low, low prices: dealnews.com, which employs a team of staff writers to comb the Web for bargains, and sends a daily e-mail newsletter with deals in categories such as storage (256MB SD card: \$32), peripherals (19-inch LCD: \$500) and supplies (50 blank CDs: \$10). The prices listed are consistently the lowest anywhere. You can also search its archives and associated sites such as dealmac.com, dealram.com and dealcam.com. Oh, and before you buy, be sure to check for discount codes at dealcoupon.com. —MIKE HANEY

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DEPT: Void Your Warranty INVESTIGATORS: Peter Rojas and Phillip Torrone

SPEAK, AIBO, SPEAK!

FINDINGS: Sony's latest robotic pet can talk like a human—now you can decide what kind of human.

TECH: Aibo voice hack
COST: Free
TIME: 10 minutes

DABBLER MASTER

While most Sony AIBO owners are content with the pet's pre-packaged dog mimicry, it has long been a favorite toy of hackers, who do things like control it remotely from a Sony Clie PDA, program it to snap photos and post them to a moblog, even teach it to disco with other dogs (chest hair and medals sold separately).

Early on, Sony threw a fit over these mods and sent several threatening letters to the owner of *aibopet.com*, a site that collected various hacks and tricks for the AIBO, saying that he had violated the company's copyright and trademarks. (An alternative theory in the hacker community was that Sony didn't like free user-developed hacks competing with its own expensive software add-ons.) A massive outcry from AIBO owners eventually forced Sony to back down, and *aibopet.com*'s replacement, *aibohack.com*, is going strong, with dozens of mods for old and new models. Start with a simple one for the new ERS-7 model (see "Changing the Voice," at right), then check out "Other Tricks" for a sampling of more advanced hacks.

Other tricks

Instructions and files for all at aibohack.com. Disco AIBO Teach your AIBOs (if you're lucky enough to afford more than one) to get down together. Scooby AIBO A little late for the sequel

but still a crowd-pleaser: turn your AIBO into Scooby-Doo. Simpsons AIBO Give your robot a personality based on either Bart (rambunctious) or Homer (lazy) from *The Simpsons*. Both will sing the theme song on start-up. AIBO Scope With a Wi-Fi network and the ERS-7's included wireless card, you can see exactly what your AIBO sees as it wanders your house.

CHANGING THE VOICE

The ERS-7 is the first model that talks with a human-sounding voice, but it's annoyingly chipper. Here's how to class up your robo-pet with a crisp English accent. (More voices are available at aibohack.com. See popsci.com/h20 to learn how to make your own.)



1 Open the panel on the AIBO's "stomach," and remove its Memory Stick. Pop the Stick in a Sony-brand card reader, and back up its contents on your PC.



2 Head to aibohack.com/ers7/index.html#AUDIO to download the new voice.



3 Unzip the downloaded file, browse to the "p" folder, and copy the file called "AUDIO.ODA" to the same folder ("p") on the Memory Stick.

4 Pop the Stick back in your AIBO, boot it up, and tell it to "take a picture." Note the refined British response. Jolly good!



5 To revert to the original voice, just replace the "AUDIO.ODA" file on the Memory Stick with the file in the back-up folder you made.

THE LUDDITE

Diary of a Tech Resister's Temptation

EPISODE 4: DIGITAL MUSIC

MONDAY, 10 A.M. My concept of an MP3 player is my girlfriend's undeniably cool iPod Mini, so I was dubious about Minidisc: It felt like having an answering machine with a big, fat tape when everyone else has gone digital.

MONDAY, 8 P.M. Recording CDs to the player is Luddite-simple, thanks to the big red Rec button. The player's controls are few, and I can easily crank the volume without taking it out of my pocket.



SONY NETMD PSYC MINIDISC PLAYER AND CONNECT STORE

\$100; sony.com

BARRIER TO ENTRY Connect is far too confusing.

THE LUDDITE LIKES Volume, replaceable batteries.

VERDICT Stick with the iPod and iTunes.

WEDNESDAY, 2 P.M. Time to buy some music. The Connect store is slow even with broadband, and the layout is labyrinthine. Worst of all, it offers only two Grateful Dead songs.

WEDNESDAY, 7 P.M. Finally manage to buy a few tracks (thanks, corporate card!). Excited to start listening, but for one problem: I can't find them.

THURSDAY, 11 A.M. Discover that I had bought but not downloaded the songs. Eventually I end up with three copies of each in my library.

FRIDAY, 1 P.M. Transferring my new tunes to the NetMD seems easy, except that the stupid software won't let me move legitimately purchased songs. I give up. —GREGORY MONE

"Restore Works!"

Every engine wears out as a result of friction during normal driving. Friction causes wear of the cylinder walls which leads to substantial compression loss over time. Your vehicle's engine has less power, sluggish acceleration, and burns more oil.

RESTORE Engine Restorer and Lubricant is a unique engine additive that repairs those worn out areas of the cylinder wall. RESTORE is the only product with the technologically advanced CSL formulation that actually fills in and seals micro-leaks on the cylinder walls. The result is increased engine compression and more engine power. Your vehicle will have better performance by restoring and balancing the compression across all cylinders. Independent lab tests prove that RESTORE really works to increase cylinder compression as shown in the graphs below.

SATISFACTION GUARANTEED

"A few days ago I added RESTORE to my 1990 VW Jetta with over 127,000 miles on it. I just wanted to tell you that it only took a few miles before I noticed a marked improvement in my car's performance. I noticed a drastic improvement on pick-up and it idled much smoother. It feels like a new car again! Thank you for a great product!"
- T.S., Anaheim, CA

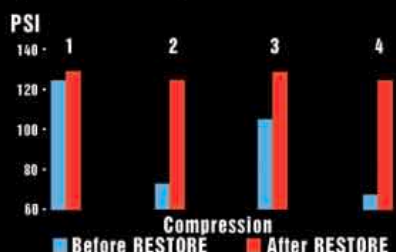
"I used your product RESTORE for the first time in May of this year. The vehicle had an engine that wouldn't stay running because 3 of the 8 cylinders had horrible compression. After using RESTORE, the engine idles smoothly and hardly smokes anymore. I am so impressed with the results, that I purchased a can for every vehicle I own. Thank you for this excellent product!"
- G.S., Henneker, NH

"I want to tell you of my complete satisfaction with your product. I drive a 1986 Chevrolet S-10 pickup with over 200,000 miles on it. I have used RESTORE for well over 100,000 miles of those 200,000 miles and I have had no engine problems. The oil is clean after every oil change and the engine is as strong today as it was in 1986. No smoke, no leaks, and at 70 mph I still get over 20 miles per gallon. I see a lot of different oil additives advertised, but your product works for me every mile I drive. Thanks and keep up the great work!"
- C.G., Topeka, KS

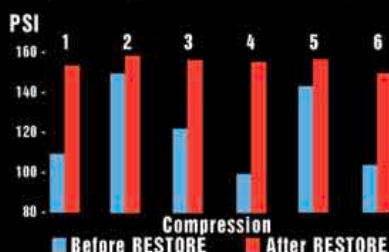


Available at all major discount stores and automotive retailers.

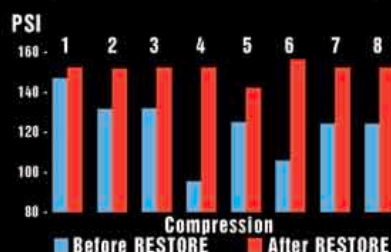
Cylinders
(1988 Chevrolet 4-cylinder with 242,104 miles)



Cylinders
(1989 Dodge V-6 with 120,903 miles)



Cylinders
(1976 Cadillac V-8 with 111,937 miles)



For more information please visit our website at: www.RestoreUSA.com

DEPT: Gray Matter INVESTIGATOR: Theodore Gray

MAKING STEEL WITH BEACH SAND

FINDINGS: Thermite powder yields pure, white-hot iron when lit. Don't try this one at home.

ELEMENT: Iron
PROJECT: Welding handle onto bolt
COST: \$20
TIME: 45 minutes

Dabbler Master

In high school, my social studies teacher talked about a substance that could generate heat so intense that a bag of it lit on the hood of a car would melt right through the engine block. Cool, eh? A Vietnam vet, he said that in the war they used blankets of the stuff to destroy sensitive equipment before capture by melting it into a puddle. (Putting holes in the odd jeep engine was just for fun.)

The substance was **thermite**, which I assumed was a complicated, exotic explosive developed by the military. Turns out it is exotic, but for the opposite reasons: It's incredibly simple, it's incendiary not explosive, and its main applica-

tion is in building train tracks, not melting spy gear.

In the thermite reaction, iron oxide is stripped of its oxygen atoms to become iron metal. The process requires a lot of

when it acquires the atoms. And what is this highly reactive substance, one of the most powerful reducing agents available? Aluminum.

Thermite is simply a mixture

Fe
Iron
55.85

ELEMENT Thermite yields pure iron
 IRON'S MELTING POINT **2,795°F**
 TEMPERATURE OF LIT THERMITE **5,400°F**
 THERMITE REACTION DISCOVERED IN **1895**
 USES **Binding railroad tracks, repairing large ships**

energy because iron binds oxygen tightly. Where does this energy—plus the energy needed to heat the pure iron to nearly twice its melting point—come from? From a chemical that binds oxygen atoms far more tightly than iron, releasing enormous amounts of energy

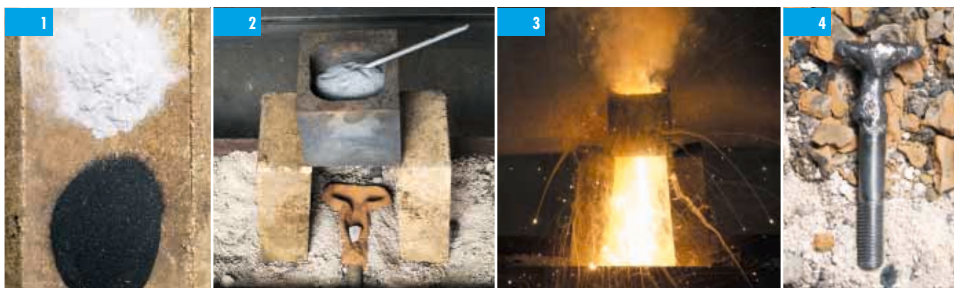
of iron oxide (like the magnetite sand I discussed last month) and aluminum powder, which I buy commercially. (Incidentally, it's also the stuff that creates the image inside an Etch A Sketch.)

I used about a pound of thermite to create a T-handle

on the end of a 3/4-inch bolt. The thermite was ignited in a graphite crucible, and the resulting half a pound of white-hot molten iron fell through a hole in the bottom into a simple clay form I had built around the bolt. The metal was so hot it melted into the end of the bolt, forming a single continuous piece of steel.

The reaction is not an explosion, but to call it vigorous would be an understatement: The mixture burns like a super-hot roman candle, consuming a pound of powder in a few seconds. It's so hot it will set on fire just about anything it touches, including me, so I ignited it in a wide-open outdoor space and watched from about 20 yards back.

Incredibly, even today this is how sections of high-speed rail are welded into seamless track, right down to the sparkler used to light the mixture. A ceramic funnel containing about 10 pounds of thermite is set off over the junction between two sections of track, fusing them into a single piece. There are few other portable ways to produce the heat necessary to do that.



1 The ingredients: aluminum powder (top) and magnetite (bottom). **2** A plug of aluminum foil keeps the thermite powder from falling through the hole in the bottom of this crucible, which is held up by a clay form. The fuse is a common Fourth of July sparkler. **3** Ignition! The thermite burns itself up in a few seconds, and the molten iron that's produced melts through the plug and falls into the form. **4** The result is a solid steel handle firmly fused to the bolt, which partially melted at the point of contact.

! ACHTUNG!

Theodore Gray is a scientist trained in lab-safety procedures. Do not attempt this experiment yourself. Find more on Gray's scientific pursuits at his site, periodictable.com. Additional resources for Gray Matter columns at popsci.com/h20.

• InfoGrid Online Music Stores

With the RIAA gone lawsuit-happy and Kazaa trading as many viruses as songs, legal online music stores are probably worth another look. Our new addition: the Russia-based *AllOfMP3.com*, which uses a weak ruble to pass the savings on to you.

SERVICE	TOTAL SONGS	PRICE (SONG/ALBUM)	FORMAT	BITRATE	DRM RESTRICTIONS	HAPPY DANCE/SAD SONG
iTunes Music Store	700,000	99¢/\$9.99+	AAC	128 Kbps	Burn 7X; copy 5X	▲ Still the simplest to use
Napster Light	700,000	99¢/\$9.95	WMA	128 Kbps	Burn 5X; copy 3X	▲ Discounts on multiple tracks
Sony Connect	500,000	99¢/\$9.99	ATRAC	132 Kbps	Burn 10X; copy 3X	▼ Proprietary file format
Wal-Mart	300,000	88¢/\$9+	WMA	128 Kbps	Burn 10X; copy 3X	▼ Limited library; no explicit lyrics
AllOfMP3.com	200,000	5¢/50¢ (1¢ per Mb)	You choose	128–384 Kbps	None	▲ Artists the others don't have, including the Beatles

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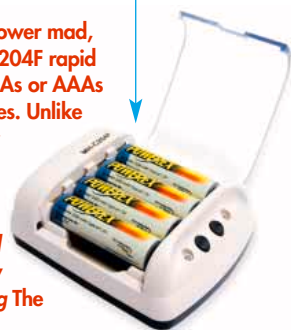


TECH SUPPORT

→ **ATTENTION H2.0 READERS:** This is your page, full of the feedback we get from you at h20@time4.com and through the forums at popsci.com/h20. **ASK A GEEK** is your chance to pick the brains of the Geek Chorus—H2.0's panel of advisers and tech wizards. **THE TIP SHEET** is a sampling of your best tips, tricks and hacks. **YOUR GEAR** features the gadgets you can't live without. (This month, we hear from the anonymous poster behind the tech blog *The Red Ferret Journal*.) Finally, **THIS IS BROKEN** gives you a preview of Mark Hurst's site thisisbroken.com.

YOUR GEAR

TECH JOURNALISM CAN DRIVE you power mad, which is why I adore my fab Maha C204F rapid battery charger. It can juice up four AAs or AAAs (in sets of two) in as little as 60 minutes. Unlike other fast chargers, it works with any brand of rechargeable battery and even has a Conditioning button to restore older cells to their pristine best. (\$25; mahaenergy.com)—*Nigel Powell, tech columnist for The Sunday Times (London) and editor of tech blog The Red Ferret Journal (enorgis.com)*



> The Tip Sheet

Remove regional DVD restrictions

Most DVDs today are programmed to work only in players from the same country, so those movies you picked up in Paris aren't likely to play at home. But you can disable the regional restriction on your DVD player by entering a special code on the remote. See videohelp.com/dvdhacks for codes to more than 2,500 players.—*H2.0 Staff*

Cut out the noise

Noise Ninja is an amazing standalone app for removing noise from digital photos. It treats shots from each camera uniquely and has a Noise Brush for fixing specific areas. (\$30; picturecode.com)—*John Carnett, H2.0 Camera Geek*

THIS IS BROKEN

SO, REALLY, WHAT DO I TYPE?

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See more examples of things broken at thisisbroken.com.



ASK A GEEK: SREE SREENIVASAN

Q: I've heard of Wikipedia, but what the hell is a wiki?

—*Kyle Stock, Charleston, South Carolina*

A: A control freak's worst nightmare, wikis are Web sites that allow anyone to make changes to them. Fans say they are the Web's promise fulfilled, a way to harness a global brain trust to make content accurate and timely. To critics, wikis are just a hairbreadth away from anarchy and mob rule.

The most prominent and, some would say, successful wiki (from the Hawaiian word *wikiwiki*, meaning "quick") is wikipedia.org, a giant, free, collaborative encyclopedia started in 2001. Today it has 709,000 articles in 60 languages and is edited and expanded by thousands of people every day. Any visitor who believes an entry has an error

SREE SREENIVASAN is H2.0's Web Geek and a professor of new media at Columbia University. He hosts the "Tech Guru" segments on WABC-TV in New York, writes a weekly column for journalists on poynter.org, and continues to expand his own massive collection of useful links at sree.net.

can instantly make a change by clicking the Edit This Page tab—no HTML needed. And if someone doesn't like that change, he or she can change it again or just undo it: The wiki keeps track of every version, so no change is permanent. Eventually the self-corrective nature of the process makes it work.

Wikis are a combination of server side scripted code and simple text. Some even allow visitors to make site-wide changes and add images.

A good place to learn more and find links to other wiki sites is WikiWikiWeb (c2.com/cgi/wiki?WikiWikiWeb), which is of course a wiki itself.

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DEPARTMENT OF EDUCATION

THINKING LIKE SCIENTISTS, NOT SCREENWRITERS

Hollywood has butchered science, eviscerated it, violated physical laws on-screen with impunity, even glee. We go to the movies and sit through noisy explosions in space, powerful handgun reports without recoil, and aliens traveling faster than light, sucking the thoughts right out of humans' heads.

Now physicists are fighting back.

A course at the University of Central Florida takes cinematic science and

uses it to educate, not obfuscate.

Under the tutelage of Costas Efthymiou, who founded the class with fellow physicist Ralph Llewellyn, undergraduates enrolled in "Physics in Films" analyze the realism of select movies, absorbing scientific information and developing critical-thinking skills along the way. One favorite target is *Armageddon*, the popcorn flick in which an asteroid "the size of Texas" is headed for Earth. The movie's solution: Launch a crack team of oil drillers to the monster asteroid to bore a hole into its center, drop in a



War Between Financiers Creates First \$11,000,000 Watch

Henry Graves and James Packard were two of the richest and most competitive men in the world in the 1920's and 1930's. Graves made millions in banking and railroads while Packard was crafting some of the most beautiful automobiles ever built. But in their genteel world of high society, they were at war. Their favorite competition...watch collecting. In 1927 Packard commissioned the world's most complicated watch but not to be outdone, Henry Graves surpassed his rival in 1933 with a single masterpiece. It took over 3 years to engineer this chronograph and only one original watch was ever built. It was held in the Museum of Time for years until it was recently auctioned off for the record price of over \$11 million dollars at Sotheby's.

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FYI

nuclear bomb, and then speed away as the asteroid cracks in two, each half just missing Earth as it flies by.

Any thoughtful moviegoer might surmise that this scenario is highly improbable. That's not the issue here—the fantastic in film is part of what makes movies so enjoyable. But there is a difference between fantastic and impossible. After a brief lesson in conservation of momentum and energy, along with basics on the power of nuclear weapons, Efthimiou explains to his students why these expert drillers couldn't save the world. No known bomb would be powerful enough to push anything so massive out of the path of a 7,900-mile-wide planet. So instead of one large impact, two half-Texas-size asteroids would strike Earth just 400 meters apart.

Efthimiou has noticed a few strange things while teaching the

course for the past two years. For one, his students seem to enjoy movies in inverse proportion to their accuracy. Students love *Armageddon*, for example, while *Deep Impact*, another asteroid-diversion movie with superior physical realism, rates low. Efthimiou has recently added sections dealing with superheroes and pseudoscience, and he'll put the fun movie/bad physics correlation to the test this fall when he screens *The Core*, which is, in his estimation, "the worst movie ever." That film—an action movie about jump-starting Earth's magnetic field—was also a critical and box-office flop. "I don't think that Hollywood will ever make a movie that has worse science than this one," Efthimiou says. But if Hollywood does, it's sure to show up one day in his class.—MICHAEL MOYER

BOOK OF THE MONTH

TRANSFORMING WIND INTO WORDS

Before sailors had computerized weather centers to rely on, there was the Beaufort scale, which reduced the

complexities of wind to simple phrases. It classified wind force into 13 levels, from "zero; calm; less than 1 [mph]; smoke rises vertically" to "twelve; hurricane; 73–136 [mph]; devastation occurs." Scott Huler's *Defining the Wind*, a new book on the scale and the British nautical notable, Francis Beaufort, whose name it bears, is surprisingly light reading for the history of a reference material. The scale, which is still widely employed, coincided with another unique achievement in science: It was first used by Charles Darwin and the crew on board the *Beagle*. Huler takes the reader through significant moments in nautical history, and his skillful exhumation of a detail-obsessed life is a joy to read.—JOE BROWN

DEPARTMENT OF COIFFURES

HAIR CLUB FOR NERDS

Great minds sometimes have great hair to match, as Einstein's famous mop and Newton's wavy tresses show. In an effort to recognize the praiseworthy manes of modern thinkers, in 2001 the *Annals of Improbable Research*—best-known for the Ig

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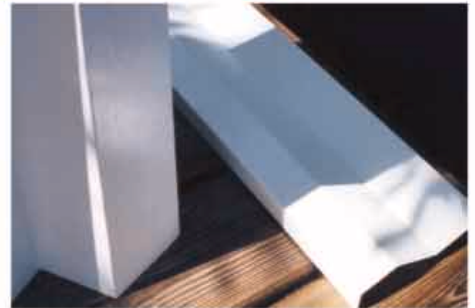
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Nobel Prizes, which go to legitimate but humorous scientific work—formed the Luxuriant Flowing Hair Club for Scientists. The first member was Steven Pinker, an MIT scientist whose long, curly locks are reminiscent of Isaac Newton's. The club's members (most of whom can be seen in the hair club section of *improbable.com*) range from Brian May, who studied for a Ph.D. in astronomy before rocketing to stardom as Queen's lead guitarist, to recent inductee Francesca Collins, an Australian doctoral candidate who explores the psychological effects of female hair loss. Applicants must present scientific credentials along with a photograph "in which the luxuriant, flowing hair is *clearly* evident."—CHRISTINA BRYZA

ENVIRONMENTAL EXTREMISM

SAVING THE STORSJOE MONSTERS!

Environmentalism has reached a new, confused extreme. Recently an environmental council in Sweden's Jaemtland province rejected an entrepreneur's request for a permit to hunt the eggs of the mythological Storsjoe Monster, a local version of the Loch Ness Monster. According to legend, the creature lives in Lake Storsjoe and has the body of a serpent, the head of a cat and several winglike fins. The entrepreneur said that he wanted to raise baby monsters as a tourist attraction, but the local environmental council turned down his request. Although it's unclear whether one or both parties were in on the humor, a subsequent investigation into the case turned up another curiosity. In 1986 the council denied a permit to a resort developer on the grounds that the proposed project would threaten the Storsjoe Monster, which had previously been declared endangered. The Parliamentary Ombudsmen's office in Stockholm is now looking into the matter, no doubt hoping that the classification of a mythological creature as "endangered" was an elaborate joke.

—GREGORY MONE

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DIY CHECKLIST

WHAT YOU NEED TO KNOW FOR HOME+AUTO

Be sure to check out our the DIY Checklist in our September issue, a special section focusing on practical and seasonal tips for your do-it-yourself projects. The DIY Checklist will provide you with the best information—where, when, how, etc. regarding the upkeep, maintenance and improvement of your home and auto this Fall.

On August 24th check out the DIY micro site with direct links to our DIY Checklist partners at www.popscl.com.

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(CONTINUED FROM PAGE 60)

department and seemed like a good possibility. Stross had never visited, nor did he feel any desire to. All the ideas he needs are right here—in his mind, his books, cyberspace. Stross is already partway to the posthuman age, whether he knows it or not. He is semi-uploaded; he builds entire universes, and experiences his own, through the portal of his laptop.

THERE'S A SENSE of anticipation at the Plokta gathering as Doctorow prepares to interview Stross in the Chequers conference room. This writer-on-writer interview is one of the weekend's highlights: two of the top minds in science fiction freely trading ideas with each other and the audience, arguing about everything from the progress of artificial intelligence to the often tenuous relationship between science fiction and science itself. Doctorow distills this last issue into a single question: "Would *Frankenstein* have been a better novel if Mary Shelley had gotten the biodetails right?"

They debate the point a bit, then Stross suggests, "Maybe she was right for her time."

SF writers bend and twist physical laws for the sake of the story—sometimes, Einstein be damned, you need faster-than-light travel to get your hero from one side of the galaxy to the other. But Stross's comment about Shelley applies directly to those who are writing about the Singularity: They try to be as accurate as they can for their time, to extrapolate from current trends.

Doctorow says he cheats only under narrative duress. In *Down and Out*, for example, when people need to be restored from their backup copies, doctors download their brains into freshly cloned bodies. The idea of ready-made clones is fairly magical (in reality, clones would begin as embryos and grow into adults in normal time), but the device is critical, as it enables a recently murdered character to jump right back into his old life to find his killer.

Respect for accuracy comes naturally to geeks, but it's also a way to avoid what Doctorow calls "peevish pedantic

corrections" from fans, who are as demanding as they are loyal. Novelist Larry Niven knows this all too well. During the 1971 World Science Fiction convention, MIT students protested the physics in his book *Ringworld* by roaming the halls and chanting, "The Ringworld is unstable!"

Stross, Doctorow and their crowd don't limit their laserlike focus to their own pet interests, or even to technology. For them, writing futuristic science fiction isn't just about understanding relativity and estimate the approximate surface area of a solar-sail spacecraft capable of traveling at half the speed of light. You have to factor in politics and civil rights too. You have to think long and hard about the capabilities of a robotic pet cat with human-level intelligence, and then you have to ask whether it should have the right to vote.

The result of such maniacal attention to detail is a host of stories that are bursting with wild ideas. Greg Egan, a computer scientist and writer who was one of the innovators of Singularity fiction, developed an entirely new theory of cosmology for the post-Singularity universe in his most recent novel, *Schild's Ladder*. He calls it Quantum Graph Theory, and the work has his fellow writers—some of whom are physicists—scratching their heads half in confusion, half in awe. (Stross has jokingly speculated that Egan, whom few if any people have actually met, may be an artificially intelligent being. Perhaps he/it is refusing interviews for fear of failing the Turing test.)

In *Appeals Court*, a story that Stross and Doctorow co-wrote, mangroves in the Florida swamps have been re-engineered to harness wind energy. And "Halo," the fourth chapter of *Accelerando*, is about as technologically dense as science fiction gets. In one scene, Amber, the daughter of Manfred Macx, receives a package from her long-lost father. The FedEx courier uses a rapid DNA sequencer to ensure that the recipient is really her, which is a fun possibility, but Stross demonstrates the true breadth of his knowledge when the package opens itself up and reveals a 3-D printer based on Bose-Einstein condensates, a highly



PopSci editors' top picks for summer science-fiction reading: popsoci.com/exclusive

unstable form of matter first created in 1995. It's a classic SF technique: While the physicists are still busy trying to find ways to create and manipulate their Bose-Einstein condensates and publish more papers, Stross is crouched over the laptop in his office, mining electronic copies of these papers for ideas, figuring out what their work might lead to in 20 or 30 or 100 years.

So are these writers predicting the future, or are they just having some highly intelligent fun? When I ask Vinge, the godfather of Singularity fiction, he paraphrases Robert Heinlein. (Science fiction is a large, incestuous family—Joan Vinge, Vernor's ex-wife, is also an accomplished SF novelist—so when you ask one writer a question, he or she often gives you another's answer.) If you have 1,000 monkeys, or SF writers, Heinlein said, some of them might get it right.

The good stories, Vinge adds, should at least provide useful guideposts for the future. "A well-written SF story is like running a simulation with certain types of driving ground rules," he continues. "When something comes up, you can say, 'You know, that's a little bit like the pre-symptoms of scenario Z.' Then you're immediately in tune with what some of the possibilities may be."

IN ACCELERANDO, the first creatures to be uploaded are not humans but lobsters. Stross says he got the idea from an article about a group of UC San Diego scientists who had created a functioning electronic version of a small section of the brain of a California spiny lobster. Stross summarizes the research paper for me but says he hasn't been able to track it down since then. Part of me, I confess, is wondering if he is exaggerating, creating a story to back his story.

A few days after I return to New York from the Plokt conference, I find the San Diego researchers on the Web and check with Stross to make sure they're the right ones. Then I forward a link to the first story in *Accelerando*, the aptly titled "Lobsters," to the scientists. A few hours later, a physicist in the group, Henry Abarbanel, calls me. He's excited but a little confused. Excited that his team's work helped to inspire a mas-

sive SF novel, perplexed because he can't find any specific reference to their research in the story, although there is lots of stuff about uploaded lobsters. We talk a bit about science fiction in general—he was an Asimov fan as a kid—and then Abarbanel explains what he and his colleagues are doing with those lobsters.

The research, led by biologist Allen Selverston, focused on the California spiny lobster because only 14 neurons govern a key part of its gastric tract. This number of neurons is unusually small, which makes the area easier to model. Still, understanding the neurobiology of those 14 neurons was not easy. It took Selverston 25 years. Then Abarbanel and his colleagues needed two more to figure out how to recreate the system electronically. This work, too, was difficult: Abarbanel likens the process to having all the parts of a 747 laid out on the floor of a hangar with no instruction manual on how to put them together to make an airplane.

All that work, and they've electronically simulated just 14 neurons. That's a far cry from uploading the 10^{11} neurons that make up the human brain. Naturally, I assume Abarbanel will laugh at the idea that uploading a human mind could ever be possible. But it turns out that he approves of Stross's leaps of imagination. "Frankly, I don't consider it to be crazy," Abarbanel says. "Whether it's five years or 10 years or 500 years, I have no doubt that we'll figure out how to do it."

This new brand of science fiction, I realize, like all the best SF before it, is not just about predicting the future or pushing an agenda or even plain old entertaining techno-fun. It is all that, but it's also about expanding the boundaries of the possible, building far-out worlds and then populating them with characters who bring the big ideas down to Earth. "That's what you're supposed to do in science fiction," Abarbanel tells me. "You make a leap that's 10 orders of magnitude beyond what we can actually do. If they don't do that, then we don't get there." ■

Gregory Mone, author of the novel The Wages of Genius, which was issued in paperback in June, is an associate editor at POPULAR SCIENCE.

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(CONTINUED FROM PAGE 72)

world's first privately owned F-104 Starfighter from scrounged parts. The project took him 12 years. When complete, the plane was 2,000 pounds lighter than a stock F-104, carried 300 extra gallons of fuel, and sported a red velvet instrument panel. On October 24, 1977, in Tonopah, Nevada, he broke the world absolute low-altitude speed record, previously set by a U.S. Navy F-4 Phantom, streaking twice through a 3-km trap at an average speed of 998 mph less than 80 feet over the desert. His record remains unbroken.

In those days, Greenamyer worked with famed Lockheed designer Bruce Boland; for his Sport-class debut he found a young composites whiz with an intuitive sense of fluid dynamics, a surfboard and skim-board maker from Laguna Beach, California, named Andy Chiavetta. With a stock 350-hp, 6-cylinder engine, the plane was capable of 280 mph at 10,000 feet—fast, but not fast

enough. (Always impatient with rule books and manufacturers' specs, Greenamyer ignored Lancair's warnings of airplane instability above 300 mph.) Greenamyer dropped in a twin super-turbocharged version with a modified crankshaft and bigger pistons. He added a water/alcohol antidetonation injection system and water spray bars to cool the beast. He persuaded Hartzell Propellers to supply him with a special large, three-bladed prop. Installed high-volume pumps on the main landing gear to suck the wheels up fast and close the doors tight. Sacrificed control for speed by eliminating the Legacy's flaps to reduce drag. Replaced the center control stick with a side-mounted one for finer control, like the fighters he was used to. Moved the forward canopy hinges to the rear so that with the pull of a lever, the canopy would fly open and off the plane, allowing Greenamyer a chance to bail.

Perhaps most important of all was the work he and Chiavetta did with the

engine cowling. "Thirty percent of the plane's drag is from cooling," Greenamyer says. In a stock Legacy, air enters the engine case through two intakes in the plane's nose, where it freely whips around, creating zones of low pressure. In Greenamyer's Legacy, the intakes are substantially smaller and a small wing splits the air, directing carefully calculated portions to the engine, which sits in a sealed plenum, and to the turbochargers. Greenamyer didn't just want to win—he wanted to destroy.

By the time he and Chiavetta were finished, the Legacy was pulling close to 500 hp at virtually its original weight, with far less drag. "I think of it as a funny car," Greenamyer says, grinning. "It looks just like any other Legacy on the outside, but inside it's unlike any other plane." He took it racing in 2002. His qualifying speed of 347 mph set a new course record. His winning speed of 328 mph would have placed him fifth in the Unlimited Bronze category against

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Mustangs and Sea Furies. The following year he qualified at 347 mph again, before blowing a cylinder in a heat race. No matter. He won again that year, edging out Rick Vandam on stock cylinders.

SO FAR UNDEFEATED IN *NEMESIS*, JON Sharp was looking around for something new. "The Sport class is the only one on a forward growth path," he says, standing in his Mojave hangar, Pink Floyd cranking from the stereo. Sharp had already finessed 290 mph out of tiny *Nemesis* for a straight-line speed record. With a clean sheet of paper and a bigger power plant, there was no telling what was possible. Instead of buying a kit, as Greenamyre did, Sharp decided to design a plane from the ground up and offer it as a kit to anyone with \$129,000 to burn, plus the cost of engine, propeller and avionics. *Nemesis NXT*, as his new plane is called, is lean and sleek like the original *Nemesis* but much more muscular—"swoopy" is the word Sharp uses: a

machine with fat, elliptical wings, wingtips that curve backward into sharp points, and a sharklike fuselage, all of which have been carefully sculpted in wind tunnels and computational fluid dynamics models. "You could never make this airplane out of aluminum," Sharp says, gently sliding a three-foot-long sanding board covered in superfine 400-grit sandpaper over wings already as smooth as polished marble. He is big and boyish-looking, with short, graying hair, braces on his teeth and a soft voice. "We'll never replace the noise and spectacle of the warbirds, but this is all about current technology, and it's moving forward fast."

Sharp has long been known for his cutting-edge aerodynamics. A native of Albuquerque who raced go-karts as a kid, he planned on becoming a dentist until he hooked up with a maker of racing sailplanes in 1972. "For years, that was the only place composites were used," he says. "I got fascinated with the smooth, glassy texture." He went to

work for Lockheed on "black" programs using composites, bought a used Formula One race plane, and started racing. But F-1 planes were all built around technology from the 1950s, he says; to reduce drag, their wings were thin. Sharp knew better. He sold his plane after a few years, went to NASA in search of new wing shapes, and built *Nemesis*. Counterintuitive though it may seem, he took a superefficient, high-lift wing—a wing that is fat—and recambered it to reduce its lift, because lift is drag. Pound for pound, *Nemesis* was the fastest plane ever built.

Now *Nemesis NXT* is a day away from the paint booth, a few weeks away from its first flight. "We used *Nemesis* as a prototype," Sharp says, "and went from there." The wings curve backward in an ellipse, keeping airflow across them straight, even at the wingtips. The sharp "sheared tips" reduce drag. And like *Nemesis*, this plane's wings are fat at the leading edge and skinny at the trailing

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edge. "The camber is really radical," Sharp says. "Most wings are teardrop-shaped, but the thickest point on *NXT*'s wings is 60 percent back from the leading edge, which keeps the airflow attached. The airfoil on Darryl's Legacy was designed for 280 mph. This is so much faster, we should be able keep up with him with a stock engine."

But *NXT*'s racing engine will be anything but stock. Lycoming is building Sharp a special engine, Hartzell is giving him a prop and Garmin \$40,000 worth of avionics—and for air racing as a whole, that corporate sponsorship is what is truly exciting about Sharp's endeavor. "For us, kit planes are a growth market," says Lycoming's Roger Pascoe, "and it's a chance for us to learn the answers to things that you can only learn by pushing our engineers to the limits of technology."

It may sound like typical race talk, but Pascoe's words are revolutionary in the world of air racing. Greenamyer is using a Continental engine, Sharp a Lycoming. Greenamyer's airplane is available from Lancair, Sharp's from Sharp himself. Competition begets innovation, which begets speed. Already, many of Greenamyer and Chiavetta's modifications are available to other Legacy builders in a speed kit that Lancair is looking to market. "Reno has been selling airplanes for us," says Kim Lorentzen, Lancair's sales manager. Within a couple of years, at least two of the *NXT* kits that Sharp has sold should be completed and racing. With innovation and competition and manufacturers' involvement, almost every little Sport-class kit plane in the field could soon be clipping the heels of the great World War II fighters and making 400-mph, cross-country, general aviation planes routine.

But first there's that little matter of a clash of the titans at Reno next month—and Sharp, for one, is getting the trash-talking started. "What Darryl and Andy have done with that plane is awesome," he says. "But it's a Corvette compared to our Ferrari."

Hearing that, Greenamyer smiles, his blue eyes twinkling. His engine is getting rebuilt again. Chiavetta is tweaking the airframe. "If I were you," Greenamyer says, "I'd be careful how you put your money on." ■

Carl Hoffman wrote about WWII-era fighters in his book Hunting Warbirds.

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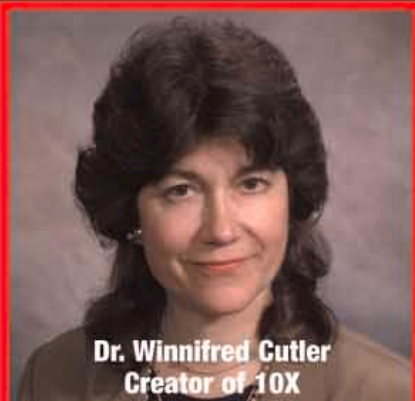
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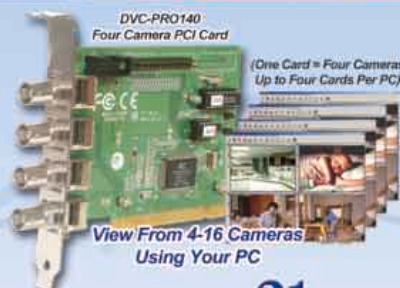


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Just who buried these coins is still a mystery. It could have been a Roman soldier, a merchant or even a barbarian chieftain who had been given the coins as a bribe not to wage war on Rome. What is known is that these coins were first issued in 330 AD by Emperor Constantine the Great. They were struck to honor the city of Rome as the cultural center of the Roman Empire in what has to be one of the most successful marketing campaigns in history. Constantine used these coins as an effective public relations ploy as he moved the capital from Rome to his new city, aptly named Constantinople. To honor the founding of his new capital—and to soothe the hearts of Roman identity—these "Urbs Roma" (City of Rome) bronze coins were handed out during the consecration ceremony for Constantinople on May 11, 330. Some experts of ancient coins agree that no other Roman coin was ever struck for such a specific event making the City of Rome coin the **FIRST Commemorative Coin of the Roman Empire!**

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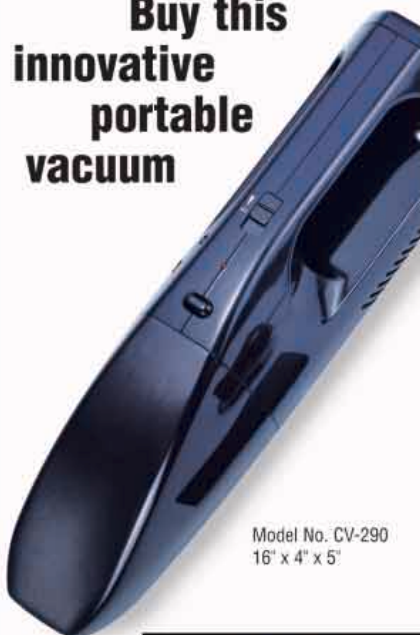
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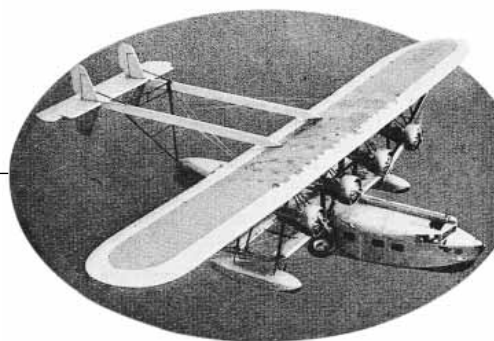
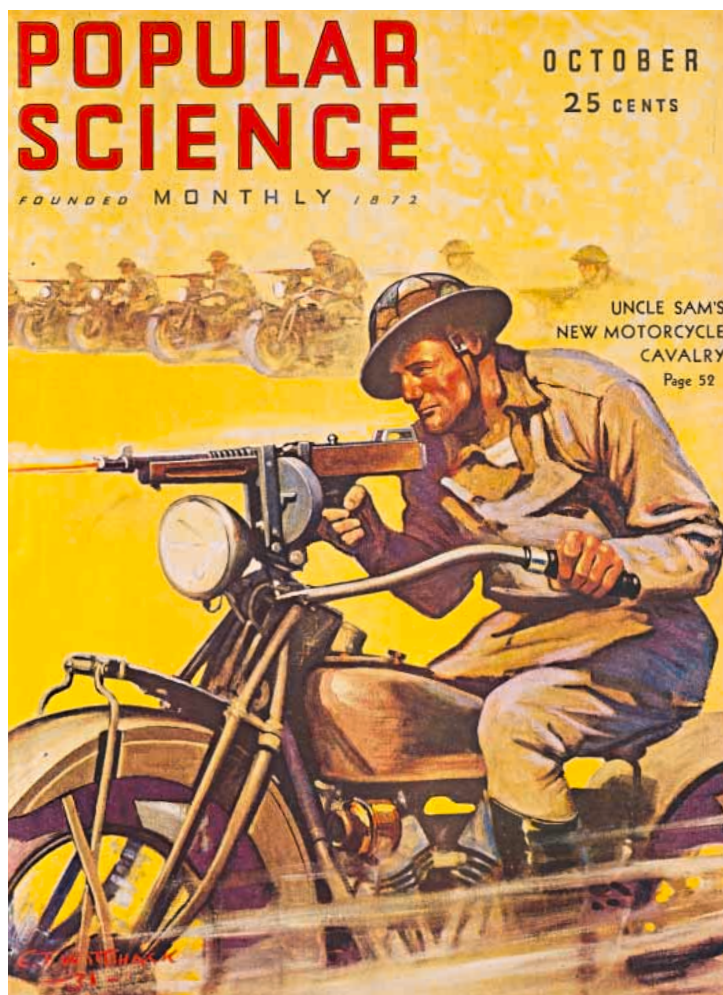
OCTOBER 1931

FROM THE POPULAR SCIENCE ARCHIVES

TWO-WHEELED FIGHTERS

Motorcycles thrilled civilians first. The military then tapped the nimble bikes for use in combat and reconnaissance.

"Spitting death from machine guns," we wrote, motorcyclists in the "first mile-a-minute army" were part of a mechanized force that replaced the cavalry when it became clear that horses were no longer fast enough to compete in modern warfare. Sparsely used in direct fighting, motorcycles yielded to jeeps by World War II as the versatile vehicles of choice for operations in rough terrain. By then, though, motorcycles already had three decades of history with the military—Gen. Pershing pursued Pancho Villa on a Harley-Davidson in 1916, just 13 years after the first civilian Harley rolled out of a small wooden shed in Milwaukee. The U.S. military bought about a third of the Harleys produced in 1917. In World War I, U.S. and European armies used motorcycles as reconnaissance and messenger vehicles as well as for combat, communications and transportation. Today motorcycles still operate in combat zones, moving dispatches and medical supplies through Iraq and Afghanistan. For more military-to-civilian tech crossovers, see page 44. —CHRISTINA BRYZA



The S-40, created for Pan American Airways.

Other stories from the October 1931 issue:

VIRUSES FLOURISH

Arthur I. Kendall of Northwestern University grew cultures of influenza and yellow-fever viruses in a slurry of pig intestines. Scientists had previously tried unsuccessfully to cultivate viruses on gelatin.

WORLD'S LARGEST SEAPLANE MAKES TEST FLIGHT

In 1931 a 38-passenger seaplane—with a 114-foot wingspan, it was the largest in the U.S. at that time—flew over Long Island Sound. Created for Pan American Airways, the Sikorsky S-40 was "equally at home on land, in the water, and in the air," we wrote. Its paltry speed and range probably explain why only three were ever built.

A PATENT FOR PLANTS

After a 1930 patent law put plant breeders on the same footing with inventors, Henry F. Bosenberg was granted Plant Patent no. 1, for an ever-blooming rose called New Dawn. The law applied only to plants made from cuttings, not those grown from seeds.

ELECTRIC TABLE BRINGS FOOD, REMOVES DISHES

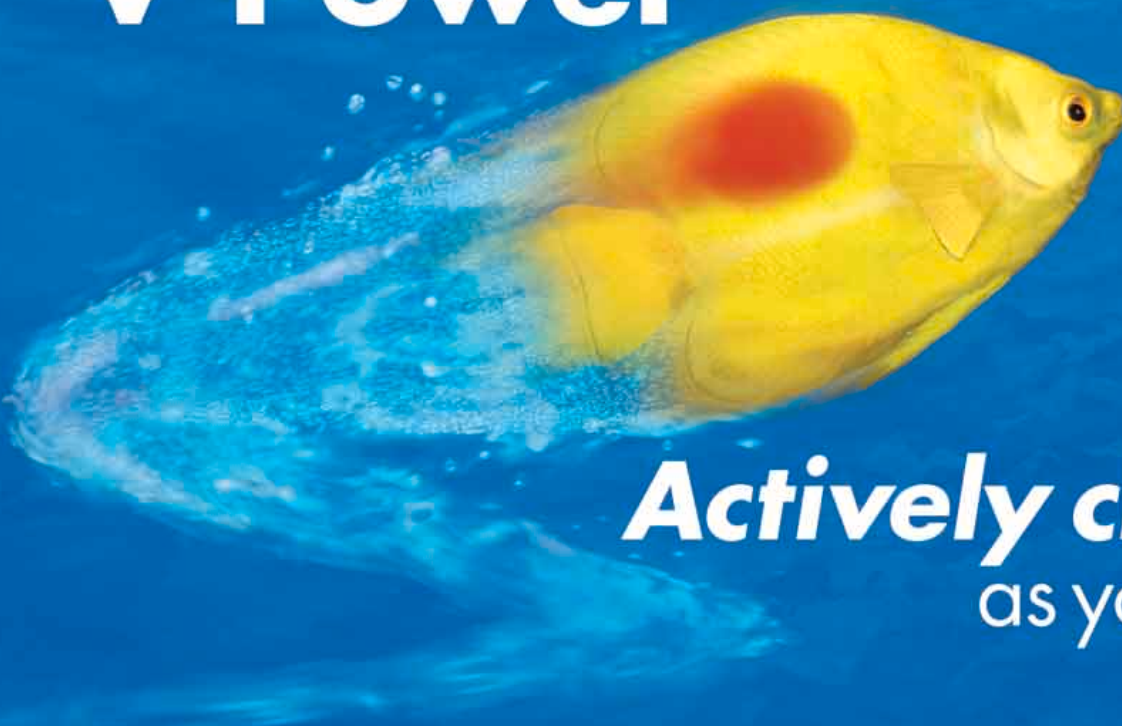
During the heyday of early labor-saving contraptions, French engineer Victor Marmonier designed a mechanized serving table. Press a button, and a movable centerpiece laden with food emerged from the kitchen, stopping at each diner so that a rotating arm could dole out dinner.

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